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NEW PROMENADE PIER, ST. LEONARD'S-ON-SEA.

On the 1st of March last, the sixtieth anniversary of the foundation stone of St. Leonard's, the first pile of a new promenade pier was started by the mayoress of Hastings and St. Leonard's. The ceremony was witnessed by thousands of enthusiastic visitors and residents. The pier is to be built from the designs and under the superintendence of Mr. R. St. George Moore, A.M.I.C.E., Westminster. The contractors are Messrs. Head, Wrightson & Co., of Stockton-on-Tees.

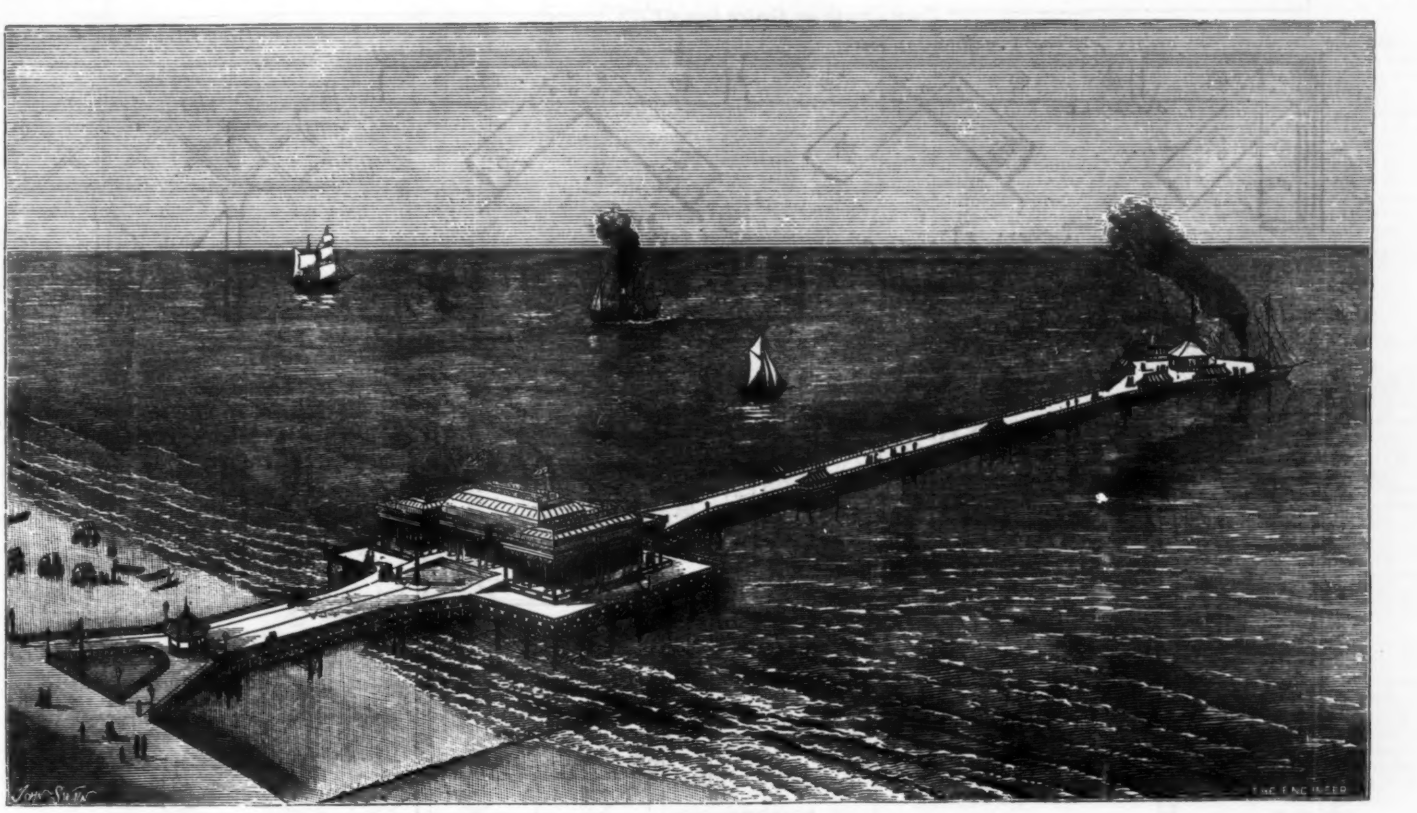
The total length of the pier is 900 feet, divided into two parts, the general rule of placing the pavilion at the seaward extremity being departed from, and instead it is placed about 200 feet from the shore. From the parade to the pavilion the pier is 40 feet wide, having a pathway on each side 10 feet wide, and a carriage way 20 feet wide, so that visitors may alight from their carriages under the porch of the pavilion. From there to the octagonal head the pier is 25 feet in width, with enlargements every 130 feet for sheltered seats. In the center of the head there is a band stand with sheltered seats ranged round it.

Round three sides of the pier head there is a timber landing stage, totally independent of the pier, with landing places 6 feet above high water ordinary spring tides at H.W.O.S.T., 6 feet below it, and 6 feet above L.W.O.S.T.; this landing stage is built of 13 by 13 pitch pine piles strutted and braced with iron.

The screw piles are 12 inches in diameter, and 1 inch in thickness. The blades vary from 3 feet to 2 feet 6 inches in diameter, and they are screwed in according to the strata from 10 feet to 16 feet. The piles are collected in groups from four to eight in number, strongly braced and strutted together; each group, therefore, forming independent and self-supporting piers. The strutting is formed of rails 56 lb. per yard, and the tie rods are 1¾ inches diameter, secured with patent lock nuts. No cast iron lugs are used, the bracing being attached to the columns by straps passing round them between two collars, cast on to prevent them slipping up or down. The columns have capitals, secured by studs riveted over, underneath the girder bed plates. The girders are lattice girders throughout, bolted together over the piles. The main joists are rolled steel, 5 feet center to center; on these there are secondary joists, 2 feet center to center, carrying the flooring, which is laid across the pier with ½ open joists.

We give a plan and elevation of the pier, necessarily to a small scale, the pier being 900 feet in length. Elevations of the main pavilion are also given, and above will be found a perspective view of the pier. The details of the girders and colonnade ironwork illustrated explain themselves.

The main body of the pavilion joins a concert hall, to seat about 600 people. The west wing is devoted to two large subscription rooms, a drawing room, and smoke room. At the east end there is a public refreshment room. Round the building there is a colonnade, cast iron columns, with cast iron arches. The main girders for the roof are semicircular lattice girders, supported on cast iron columns, embodied in the wall of the building. The total estimated cost is between £19,000 and £20,000, or $100,000.—*The Engineer.*



NEW PROMENADE PIER ST. LEONARD'S-ON-SEA.

RAILROAD LOCATION—FIELD PRACTICE IN THE WEST.

By Willard Beahan, Member of the Engineers' Club of St. Louis.

[Read April 4, 1888.]

To know what location is best for a railroad is one thing; to be able to make that location is another and a very different thing. In other words, it is one thing to be a good locating engineer: it is another thing to be a good chief of a locating party. To be the one does not imply that you are therefore the other, even in point of knowledge. Within the limits of this brief paper is no allusion to the theory or science that is the province of the locating engineer. That field is too broad, and is as yet quite unmapped country to me. It has been said that those who have traversed it the most are most silent about it; while those whose steps have scarcely gone inside its boundaries are most voluble concerning it.

It is my purpose to touch upon the subject of railroad location from that lower plane, the standpoint of a chief of a locating party. It is my wish to call some little attention of the members present to this subject, and so gain the appreciation of at least younger men, who in so large numbers look to the location of our growing railroad system as a promising field for their future work. From these younger men, who may learn in time to become able chiefs of party, it is hoped that, through study and experience of higher matters, a generation of railroad engineers will develop among whom we may find in the future a few locating engineers of sound theory and able practice.

For this paper it is assumed that all statistics as to direction and volume of traffic, districts or cities to be passed through, assistant engines to be used, with all kindred topics, have been foreseen and a decision reached. The company building the line, whose will is voiced by its executive board, chief or locating engineer, have issued their instructions. The line is to start at a stated initial point, pass through other points, towns or mining property, and end at a stated terminus. Under certain relative proportions of obstacles met, these instructions are qualified. On the route a certain maximum gradient per station of 100' will be used on tangents, and the equivalent maximum gradient on curves. A certain least radius of curvature will be preferably used, and a certain other, and less, radius be in no case passed. The length of this line in excess of least distance through controlling points must be economized, and the incurring of heavy grading not unavoidable must be shunned; all in a degree usual with that company or class of road.

With a full and clear understanding of what his employers wish to do, it now rests with a man employed as a chief of locating party to organize and equip that party, and make all future reconnaissances, preliminaries, and location. We pass over all matters pertaining to organization and equipment; that structure too often founded on whim and circumstances, in which the largest room is the room for improvement.

There are two distinct systems of railroad location. From these two or their modifications the chief of party must choose, viz.: 1. Running with his party a preliminary line on all routes or combination of routes offering any promise throughout the belt possible to occupy. Then from a comparison of their maps and profiles, select the route for the located line. This is the method of "reconnaissance with full party."

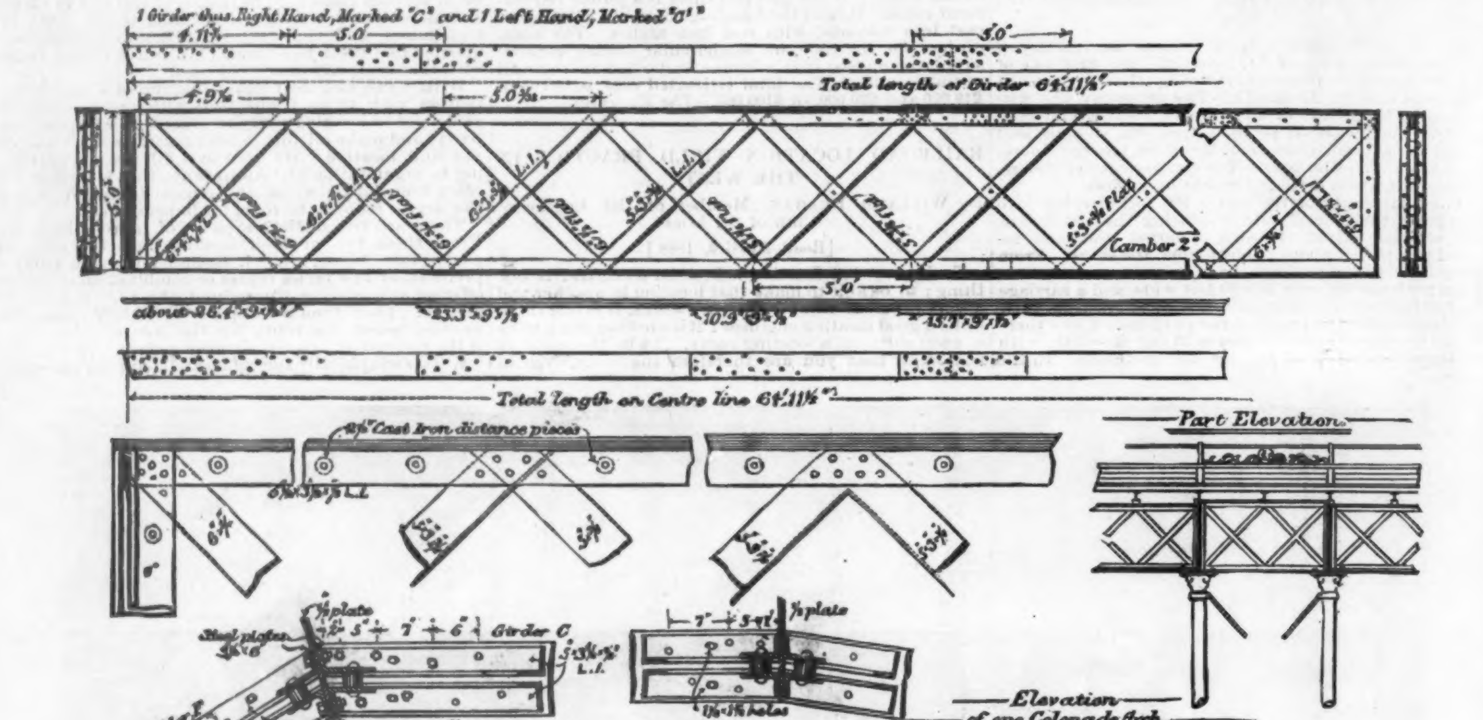
2. Topographically surveying and mapping the entire belt of country possible to occupy, and then making a paper final location on this map. Then run in this platted location on the ground. This is the method of "office location."

The first method is the one formerly used in a great degree in this country, the second is now used in the old countries, I understand. Each system has its advocates, in a degree, at least. Briefly stated, it appears to me that the objections to the first system are that it is unsafe and expensive. It is unsafe because you cannot know but that there may exist a better route than any you have occupied, even when you think *all* have been occupied. Then, too, it is possible to follow an excellent route in such a careless way as to condemn it. It is expensive because it usually involves the running of much preliminary line that a close reconnaissance by any one would show to be worthless. Again, it alway involves endless backing up. A successful chief of party is known by the amount of backing up he never needs to do. It is the transitman's method. It is slow; it is lazy. It is rough guessing without compass or other aid to map the way in advance. It will never disappear as a method, for any man can use it, and draw his salary and give less equivalent for it than by using any other method.

The objections to the second system are that it takes too much time and costs too much. It is a topographer's method; and it is an office method. No scale is as large as nature's scale; hence office location is handicapped as against field location. It is unnecessary in easy country; in difficult country it takes a better railroad engineer than a topographer to apply it safely and on a reasonably narrow belt which will always be found to contain the best final location. A modification of this second system is sometimes resorted to by painstaking chiefs of party when they encounter very

difficult country for a short distance. It is the student's method, and will be followed by those of less experience in such field work. It appears to me that, used on the difficult short portions of a line in connection with an earlier personal reconnaissance of the entire line by an experienced chief of party, much chaining and consequent cost could be saved where it is wished to merely examine a route thought of for future lines.

Instead of following strictly one of the two systems mentioned for railroad location, a rare occurrence in practice, the following modified one is suggested as better, and to it your attention and criticism is invited. The chief of party, having secured the best large scale map of the region to be passed through, takes his letter of instructions and draws accurately and sharply upon his map a straight line from the initial point to the first controlling point in instructions; from thence therefore the cheapest and best line, other things being equal. His finally located line, whenever it is found on that pencil line, needs no excuse for its being there when obstacles on it are not in sight. But if at any point his finally located line is not on that pencil line, he must be able to give good reasons for its not being there. This philosophy of direction is plainly self-evident, but not one-fourth of the chiefs of party in this country to-day realize the force of it. Of course, the object of his first reconnaissance is to find secondary controlling points. These are topographical points, and before returning to the initial point the chief of party must find the first of the secondary controlling points to be passed through. From that point back to the initial point he must sketch the country, topographically marking natural objects and indicating plainly on this sketch where the line should, in his judgment, be run from the initial to the first of the chief of party furnishes a sketch and description to guide the topographer for the whole of the next day. Each day the chief of party is steadily on horseback, and with his map and pocket instruments making reconnaissances ahead of the party. He must at all times have selected the most promising route, and the details marked out, for ten or fifteen miles ahead of the party. He must ride constantly, and except an unusually difficult point be met, he must not be within sight of any of his party in daylight. He must find all routes of any promise whatever, and fully examine them all. He must determine in advance where more than one preliminary is needed, and why. He must do some guessing, but never let it pass without verifying it with some instrument. He must be able to tell with some certainty whether a route is feasible, or his alignment or profile will be too difficult. But if he cannot, as a rule, tell whether a route is reasonably



NEW PROMENADE PIER, ST. LEONARD'S-ON-SEA.

straight lines through the successive controlling points to the terminal point. This is a broken right line passing through the primary controlling points. With this map, a pocket prismatic compass, a good hand level, an aneroid, and field glasses, he should then ride over the country, keeping as closely as possible by compass or section lines to the pencil lines on the map. He must note carefully how the topography lies with reference to that map, sketching the details. Elevation of main divides above drainage crossed, with estimate of distances apart, are important. He had better ride over the entire line. He *must* ride to the first primary controlling point beyond the initial point. On his return he should check by repetition his previous aneroid readings. He should especially notice, at points where his pencil line passes over impracticable country, on which side of that line there offers a feasible route *nearest* the pencil line. He must never forget that this pencil line being the shortest line is secondary controlling points. He gives this sketch to the topographer of the party, explaining it fully, and bearing in mind that the topographer must be able to recognize any point from the one back of it.

Natural objects, or drainage, crossings of streams or saddles on divides, needle bearings, angles to be turned, horizons shown in outline, or a gradient to be used are among the methods of indicating the route. Details must often be left to the topographer, and ample discretion allowed him. The topographer has charge of the line party during the day; points out the route by the aid of the sketch, and the line is so run. He takes usually wide, general topography in easy country, and narrow, close topography in the difficult country. He takes only that which he thinks necessary for preliminary use. At times he must take minute topography; at times he may take very little. This man must be an engineer of experience. On preliminary running this method is followed from day to day. Each night the practicable under his instructions without running a line in it with his party, he must resign, and had better go as topographer on some party whose chief has a better eye and judgment.

The preliminaries may be carried through to the terminus or may stop at a controlling primary point. To stop at a secondary controlling point is not so safe. I prefer to stop in ten or fifteen miles, to run all second or modified preliminaries, and then to start locating for a short distance, alternating the one with the other. One can do better work on location when the country and the preliminaries in it is fresh in the minds of all. It may occasionally involve abandoning located line, but I have never lost any. It is safe if you have made a correct and far reaching reconnaissance. This method always presumes that. Each night the transit line of the preliminary is platted to a scale of one inch to one thousand feet on a continuous roll, and the topography penciled in. The profile is platted and a

grade line laid by the chief of party. Before the party has run the last day on preliminary, the chief of party must walk over the adopted preliminary line for a distance out from the initial point sufficient for one day's location. He must mark on the map and profile which he carries with him for that purpose where the located line should be placed. Usually the transit line can now be drawn quite closely on the map. The topographer with the aid of these notes, or map and profile, now starts the location, following these directions with discretion. He drops the location when within a safe distance of the end of the present preliminary. The chief of party must examine the located line in the field and see that no errors have occurred. The transit line topography and levels are platted on location each night, grade line, openings, classifications, etc., noted carefully on profile.

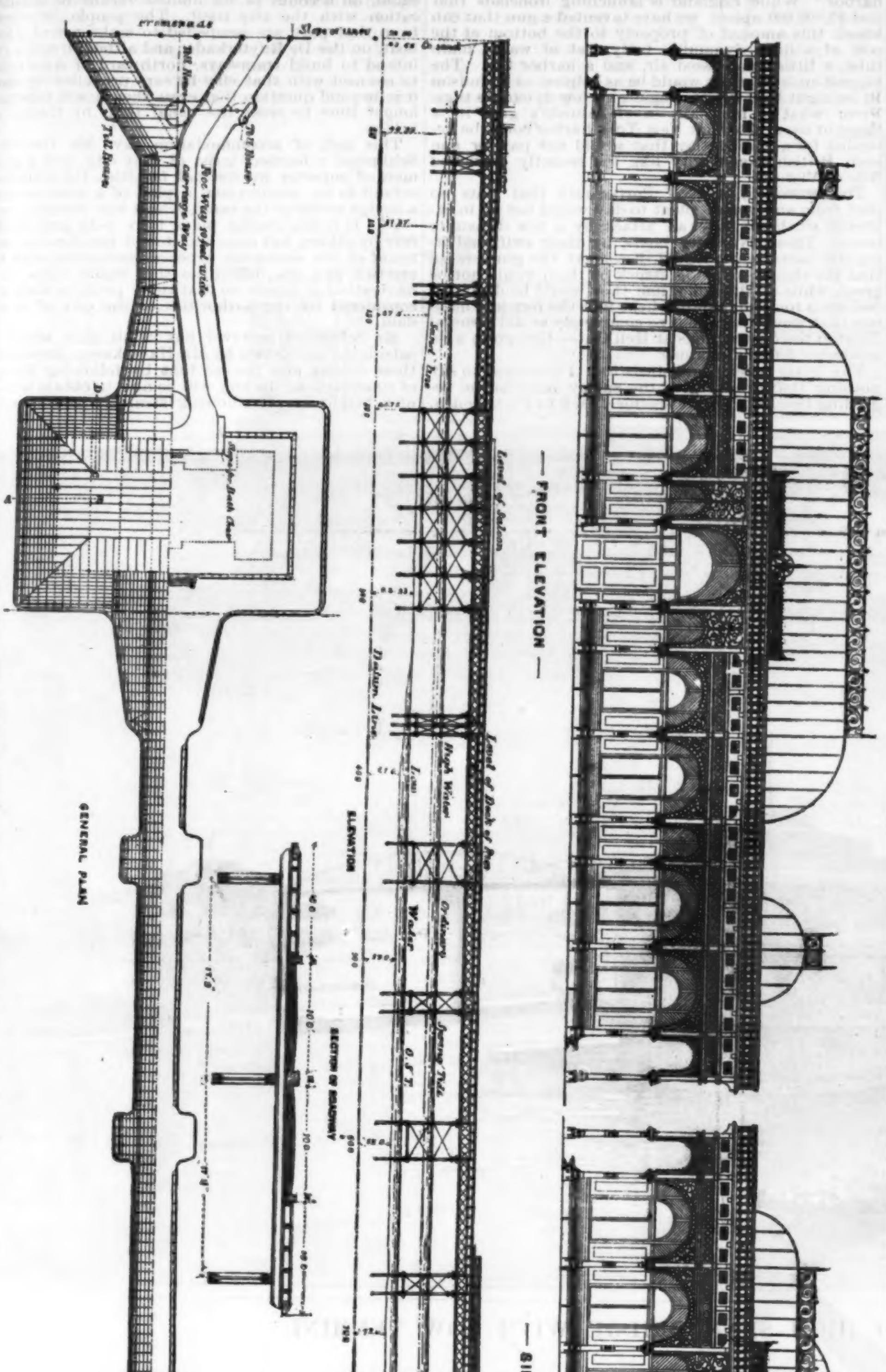
The preliminary is now resumed. In difficult bits of country a first preliminary is run with very full and minute topography, and side heights taken well out with the level where slope changes. This part of the line is platted separately to a scale of one inch to one hundred feet. A grade line is then to be assumed if it be a difficulty through gradient; or an alignment is to be assumed if it be a difficulty arising through alignment. The preliminary as modified on paper must now be run after which the line can usually be located. While every unusual difficulty is a problem by itself, as a rule I have found the above plan successful and rapid.

In running the modified preliminary, where the difficulty arises from gradient the level must be run ahead of the transit to find points for the transit's course. Hand levels can be used on this work instead, but our instrument makers have given us no hand levels as sensitive as good nerves can hold readily. We need hand levels whose bubbles have longer radii. Our prismatic compass is in advance of the hand level in point of sensitiveness and also in portability. In fair weather, by checking back, my aneroid barometer has never misled me, and is an aid. The adverse reports of others who have used gradienters on their transits have deterred me from feeling sure of their value. They are reported unreliable. They would aid the topographer, and I should like information from those who have used them many months on railroad location. If any present can inform me as to the practicability of ribbon chains—sometimes called band chains—for such work, it would be information quite appreciated. Link chains wear too much, and on curves their accuracy is less than the transit's sighting and centering. We must make progress in this direction. A ribbon chain must be thoroughly tried.

This system of railroad location has been described as clearly as is easy within the limits of this paper. I trust others will suggest improvements, or a better and entirely different structure. This method was taught me in sharp outline by valued superiors. Twelve hundred miles have been run by me in this way for one company, and my efforts and those of excellent assistants have always been to devise improvements. No space offers to discuss details. Some believe that a system should be devised to enable any novice to safely locate a railroad. Is such a system economically possible? Others think that the chief of party described is a man rather hard to find. But to this my reply is that the system grows such men. A graduate of any of our better engineering schools, starting as level rodman, becoming in turn levelman, transitman, and topographer, has grown to a position as a chief of a preliminary party. His training has cost nothing to any one, either in salary or blunders; and he has then the very pleasant satisfaction of knowing that he has been a first-class man from start to finish, need never feel a shaky foundation under him, and commands respect of subordinates.

The respect of subordinates is harder to get and of more value than the respect of superiors—to which it is the only safe stepping stone. This system is not a one man system.

With a good education, hard work, sturdy health, good habits, good eye, study, judgment, and that summation of stanch qualities termed manliness, any boy can grow to be a successful chief of locating party. Talent and inspiration I must leave out of the account, as I know nothing of them. That this system, when successfully used, is rapid is evident. If it be rapid, it is therefore cheap. A system based on ample reconnaissance by an experienced man should be safe. It requires faithful, intelligent work on the part of all members of the locating party. It seems to me to possibly resemble the system of the near future for the Western railroads of this country.—*Jour. Asso. Engineering Societies.*



NEW PROMENADE PIER, ST. LEONARD'S-ON-SEA.

PORTSMOUTH AND ITS FORTRESSES.

[*Correspondence of the N. Y. Commercial Advertiser.*]

PORTSMOUTH, May 18, 1888.—This town contains about 135,000 men, women, and children who live by the bounty of the British government. On all sides are the evidences of this, for every building beyond the proportions of a plain dwelling house appears to contain machinery devoted to the making of war material. This house makes ship biscuit, the next turns out thousands of pulley blocks at short intervals, then looms up a great marine hospital, and finally, greatest of all, are the massive dry docks where ironclads are hauled up for repairs. The harbor is full of war ships. More than a thousand guns defend the place, and it has been estimated that the lines of fortifications flanking the harbor, if placed in a straight line, would stretch from the City Hall to West Point along the Hudson, or to Bridgeport along the Sound.

A force of troops about as large as the whole standing army of the United States is required to look out for this little place, for it is one of the articles in a good Englishman's creed that the moment his vigilance on the eastern coast is suspended, the French will promptly steam across the channel with an indefinite number of men and devastate the country. It is this deeply-rooted feeling that makes the British taxpayer cheerfully vote nearly $200,000,000 a year for shot and shell, while he grudges the little money he spends on schools.

Of all Portsmouth's defenses, however, those that have cost the British taxpayer the largest amount of money to the square inch are three little stone and iron turrets sunk into the shoal water between the mainland and the Isle of Wight. They are down in every English guide book, at least in Baedeker, but no guide book is likely to waste its space in telling much about a fort from which its readers would probably be rigorously excluded.

Captain Smashpipes asked me one fine morning to go with him to the largest of these three forts; an invitation that was enthusiastically accepted. A government steam launch was placed at our disposal, for Smashpipes is a very important man, and we were soon merrily puffing in and out among great ironclads, hurrying toward the mouth of the harbor.

Our little steam launch puffed away toward the Isle of Wight, and the great Horse Sand fort began to look like the turret of an Ericsson monitor floating out to sea.

When we reached the landing steps of the strange fort we were seeking, we found moored there a sailing vessel about as large as a North River sloop. She was chartered to take cannon, and could carry two on each trip. This gives a rough idea of what a cannon weighs and of the space it occupies.

Entering the little aperture in the side of the fort, which seems like that of a ship, I found the nautical idea still further illustrated, for we stood on what seemed a ship's deck, the ports succeeding one another in a circle, and nearly the whole space from floor to ceiling being occupied with big guns and the machinery belonging to them. In fact, so crowded was the space that much of the machinery for supplying the guns had to be specially arranged so as to work at all.

The authorities have been for the last six months substituting for the present armament heavier guns still. They have had 38-ton guns. Now they think they need a couple of dozen pieces weighing forty-seven tons apiece. There are portholes enough for twice that number, but it is proposed to have a rapid-firing

Hotchkiss gun at every other hole that will put an indefinite number of 6 pound projectiles into any venturesome torpedo craft that is caught lurking in the neighborhood.

Two 47-ton guns had been mounted, and these Captain Smashpipes wished to inspect critically. He hailed an artilleryman to get an assistant and come and work the gun for him. These two pulled and hauled and jammed and grunted, and finally admitted that there was something that wouldn't work at the breech and that they couldn't load it. These guns had been six months in position, and yet in these six months they were not, apparently, in a condition to be used against an enemy. Captain Smashpipes, who is very strict, was very angry at this state of things, and said it was a disgrace to the service.

Walking over the fort did not take longer than walking around the deck of a first-class ironclad. The wall itself consists of an outer circular bomb-proof ring of stone and iron, in which the fifty-odd guns are mounted and the men are quartered. In the center of this ring is a turret, containing a well reaching down to pure, sweet water at a depth of 500 feet. Here is also the galley, the electrical room, and stores of all kinds. As it is mostly beneath the waters of the channel, there is little light, and that little is supplied by very few and very bad lamps. The galley was so dark that the cook might have been pardoned had he mistaken unpeeled for peeled potatoes. In the electrical room, from which communication was had with the mainland and the various submarine torpedoes infesting the neighboring waters, the light was what you might expect in a coal cellar. Captain Smashpipes cheerfully hoped they would soon introduce the electric light—and a layman might pertinently query, Why was it not done ten years ago? The schoolship Vernon is lighted from stem to stern in that manner; so are most of our Atlantic liners; so are even some of the railway carriages; and yet here is a fort, presumably managed by scientific officers, whose electrical room is lighted in a manner that would disgrace the forecastle of an American clipper. This fort, with its two sister ones, is supposed to be invulnerable, as well as capable of destroying anything coming within its range. Its walls are of a thickness that may well defy any shell known to England; it is bomb-proof at every point, and of course safe against an assault by boarding parties.

But before the third 47-ton gun is pointed from its port, it will probably be found that, instead of this size, they must have a 58-ton gun, if not a 100-ton one. Great Britain has now three guns that can pierce more than thirty inches of armor, while France has only eight ships that can stand up under twenty inches of plating. But what is to prevent the next few years from bringing forth ships with armor that will not mind the forts of the "Sand Horse" any more than the bite of a sand horse-fly? While European war officers are scratching their heads over the problem how to raise more money from people that are already overloaded with taxes, and how to build bigger guns and bigger ships, we have solved the question at a much smaller cost.

There was once a boy who had to write a composition on pins. He commenced in this wise: "Thousands of lives are saved every year by pins."

"How is that?" asked the teacher.

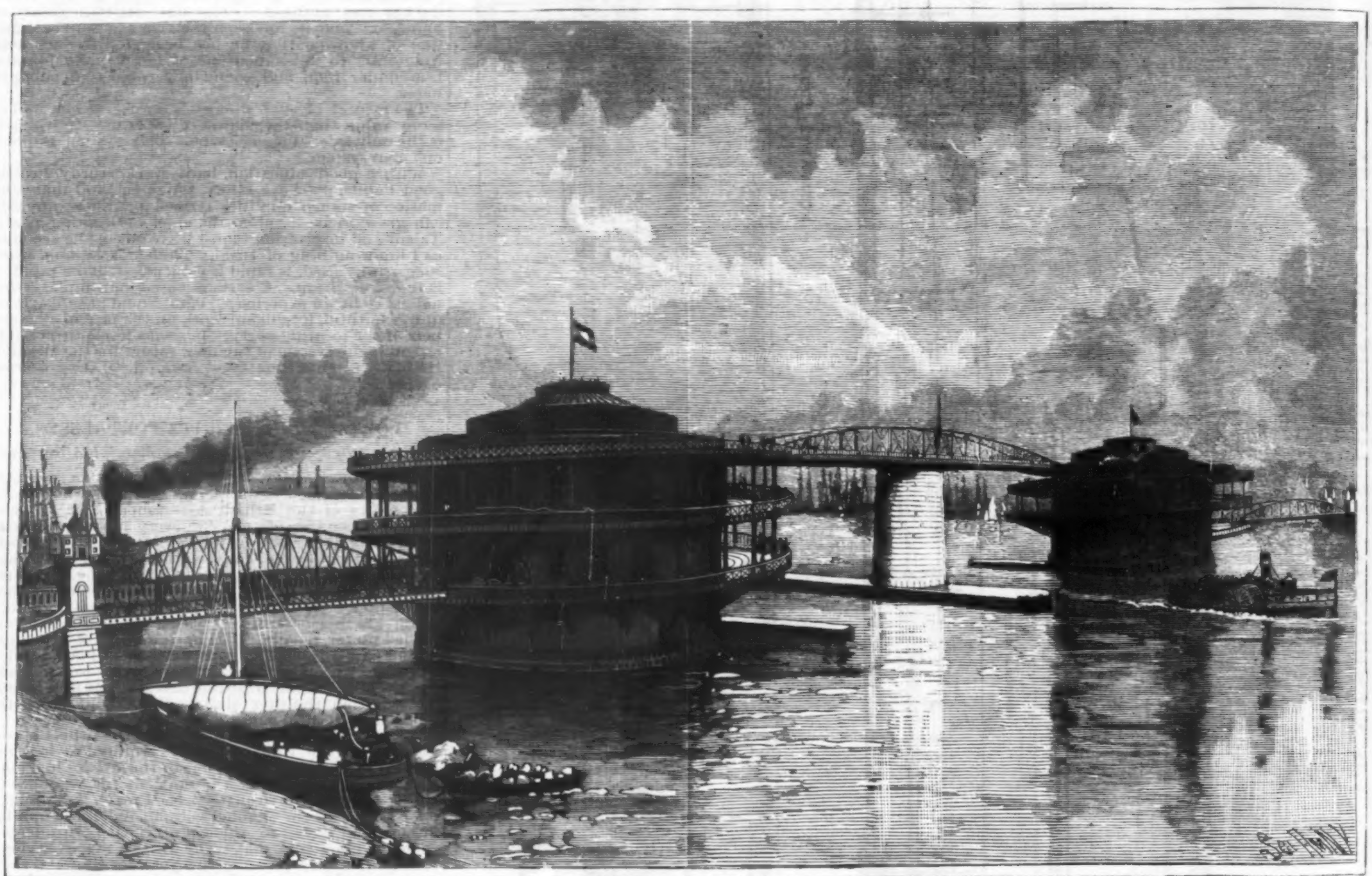
"By not swallowing of them," answered the precocious oracle.

What millions of money the United States have made by not building men-of-war can only be calculated by summing up the expenses under this head incurred by Great Britain since the Merrimac and Monitor duel.

The surprise occasioned by the appearance of the little Yankee cheesebox in Hampton Roads is only eclipsed by that of thoughtful English naval officers at the performance of our dynamite gun in New York harbor. While England is launching ironclads that cost $5,000,000 apiece, we have invented a gun that can knock this amount of property to the bottom at the cost of a little dynamite, forty feet of water, main tube, a little compressed air, and a harbor tug. The biggest cruisers afloat would be as helpless as a Hudson River night boat if pitted against a few dynamite tugs. From what is now known of Zalinski's gun, it is thought over here that New York harbor could be defended for a cash outlay that would not pay for one such British monstrosity like the recently launched Nile or Victoria.

This wonderful fort off Portsmouth that fears no shot from any vessel afloat to-day would not be in existence six hours after an attack by a few dynamite boats. These dynamite boats, by their swift and irregular movements, would disconcert the gunners so that the chances of being struck by them would not be great, while at the same time they would be dropping ton upon ton of dynamite shells into the fort in a manner that would remove it as completely as did General Newton the obstructions at Hell Gate—though in a remarkably different manner.

This letter is devoid of statistics. I promised to say nothing that would give the enemy information regarding this fort. As we steamed back to Portsmouth, however, Captain Smashpipes and I discussed the value of the great guns that were being mounted. If I am not mistaken, we reached the conclusion that they would be very good things until a fleet of Yankee dynamite gunboats hove in sight, and that when that happened the wisest thing for the Spithead forts to do would be to retreat as rapidly as possible to the mainland after arranging for an explosion that would prevent these forts from falling into other than British hands. POULTNEY BIGELOW.



IMPROVED HIGH SPAN BRIDGE WITH LOW TERMINI.

NOVEL TYPE OF HIGH SPAN BRIDGE.

OWING to the enormous expense of acquiring real estate for the construction of the approaches and termini of bridges in populous districts, a most interesting engineering problem is presented in the designing of bridges in which this difficulty is to be avoided. The bridge illustrated in the accompanying engraving is of this type, the shores being little above the water level, the stream being a navigable one, and the necessary condition being that the span should be sufficient to allow several ships to pass under simultaneously, and of sufficient height to permit vessels of ordinary size to pass under without the necessity of opening the draw. This bridge was intended to be erected across a wide canal running through Amsterdam, Holland, and engravings were prepared from the original designs of Mr. E. Haverkamp, C.E. The conditions which governed the building of a bridge of this description were as follows:

The city of Amsterdam, Holland, is built in the form of a half circle, the center of which is situated near the central railway depot, its diameter being the North Sea canal. The population of this city, now about 400,000 souls, is continually increasing, and consequently also its number of houses and streets. Some of the latter ones are already extending the boundaries of the city, which makes it desirable that new buildings should be erected on the other side of the canal, where the lots form a direct part of the township of Amsterdam.

But the citizens object to build on that part of the canal, on account of its limited means of communication with the city itself. The people, in starting from that part, are compelled to make use of a ferry-boat, on the De Ruyterkade; and although other cities intend to build tramways, northward of Amsterdam, to connect with that city by cars propelled by steam, it is beyond question that even then it will take much longer time to cross the canal than by means of a bridge.

This lack of accommodation gave Mr. Gerard W. Schimmel, a learned jurist of that city, and a gentleman of superior intellectual faculties, the impulse to submit to his countrymen a plan of a construction of a bridge crossing the canal, which was formerly called "Y." It is true similar plans have been projected before by others, but none was found practicable, on account of the enormous expenses connected with their erection and the difficulties they would cause to the navigation of vessels, so that these projects were never considered by the authorities of the city of Amsterdam.

Mr. Schimmel, however, has in his plan, which was calculated and drawn by Mr. Haverkamp, provided for these defects, and proved that by following his mode of construction, the city will be able to obtain a bridge of a height amply allowing steamers and vessels of small dimensions to pass under it and only to open this bridge for the passage of larger steamships.

On a first view of Mr. Schimmel's project, it would be supposed that in order to obtain this result, it would be well to provide the bridge with entrances equal to those of the Brooklyn bridge, but that would be impossible by the lack of sufficient space at the aforesaid De Ruyterkade. Therefore Mr. Schimmel in planning his project was compelled to follow another system.

The bridge is projected for the use of carriages, street cars, and passengers. The width of the road, not including the tramway, is 32′ 6″. That seems to be too much, but now we have the great advantage that near the foot of the tower there is no width less than 19′ 8″, so that two carriages can pass each other without touching the rails. The gauge of the tracks is 4′ 7⅝″, and equal to that of the Amsterdam street car company. The tracks on the swing bridge are traced symmetrical with respect to its axis, so that the bridge can always be turned in the same direction.

DIMENSIONS OF THE ROADS.

Part of the bridge.	Sidewalks.		Road.	Tramcar.	Total.
	Number.	Width.			
Approach	2	8′ 1″	32′ 6″	16′ 3″	64′ 11″
Gallery	1	8′ 1″	19′ 8″	16′ 3″	52′ 1″
Swing bridge..	2	8′ 1″	19′ 8″	16′ 3″	44″

Both approaches have a length of 196′ 8″ between the centers of bearing, with a grade of 1 : 40. The distance between the lower part of the main girder and the water surface is, on an average, 13′. Near the towers

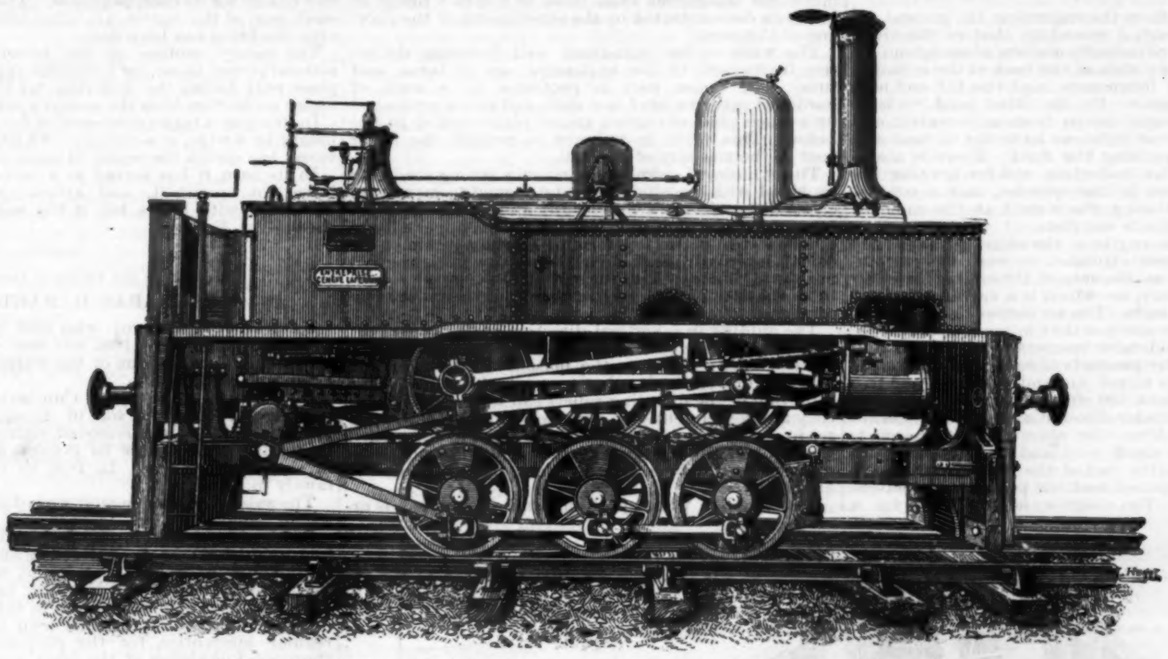
they are supported by means of consoles, going through the center of the tower, having a length of 177', and near the wall of the tower a height of 14' 7¼". Those consoles are supposed to be constructed of wrought iron tubes, three for each console, strongly connected with each other. The clear opening of the turn bridge is 91'. This is sufficient, because the new lock at Ymuiden, the sea end of the canal, will get a width of 81' 3". The bridge is supposed to be opened with hydraulic machines, placed in the center pier. The distance between the lower part of the main girder of the swing bridge and the water surface is 48' 9". The towers have an outward diameter of 143', and are constructed of stone. In the walls are windows to lighten the interior. The inner part can be used for making offices, lifts, and, when necessary, a footpath with a grade of 1:50. After having turned once round the tower, we have mounted 13' 9". This number could be easily increased, without changing the grade, but then the diameter of the tower would grow too large and the latter take too much space in the canal. As a matter of fact, the grade of the floor round the tower is not everywhere the same, as is shown below:

Part of the way round the tower.	Traffic. Up.	Down.
Street car	1 : 38·2	1 : 34·4
Roadway	1 : 46·6	1 : 42·1
Sidewalk	1 : 53·3	1 : 53·3

The upper part of the tower is covered with a roof, under which are the entrance to the lift, the waiting rooms, and the other accessories.

LOCOMOTIVE FOR NARROW AND BROAD GAUGE RAILWAYS.

THE accompanying engraving illustrates a type of locomotive engine devised by Mr. Laferrere for use on the service tracks at the Chaillouë ballast pit, the gauge of which is 3¼ feet. For the purpose of technical researches, and, at the same time, with a view to economy, he decided to modify the engine so that it could be run upon both the ballast pit track of 3¼ feet and the main track of 4¾ feet gauge. The problem was ingeniously solved as follows: The locomotive employed for this purpose is a ten-ton engine designed for a 3¼ foot track. When it is run upon a 4¾ foot track, it is mounted upon a truck of which the wheels are of a slightly less diameter than those of the engine, and are strongly mounted. Under these circumstances the two driving wheels alone remain free, and their axle rests upon bearings supported by the truck. Nothing in the motion of the engine is then changed, save that the coupling rods are dismounted and placed upon the wheels of the truck. In order to transmit motion, an intermediate shaft terminating in two cranks is placed in two pillow blocks at the back of the truck. Two connecting rods placed upon the driving wheels, in lieu of coupling rods, connect these wheels with the intermediate shaft. Two other connecting rods connect the shaft with the hind wheels of the truck. In order to compensate for the difference between the gauges of 3¼ and 4¾ feet, the main connecting rods are slightly bent at their extremities. The movement of the brake in this modification remains the same as it was before, save that the forward blocks are transferred to the front wheels of the truck. When the brake screw is moved, the driving wheels of the engine and the front wheels of the truck are simultaneously locked.



LOCOMOTIVE FOR BROAD AND NARROW GAUGES.

This engine has been used on the broad gauge tracks at the quarry pits, where it has maneuvered the platform cars, and has made up trains at pits exploited by the excavator. About twenty-one million cubic feet of ballast have been handled since 1876 by the locomotive thus mounted upon its truck, without any accident or damage having been reported. The addition of a relatively heavy truck has the effect of lowering the center of gravity of the whole and increasing the adhesion upon the rails. This, in connection with the diminution in the diameter of the wheels, has the quite curious effect of finally increasing the power of the locomotive while mounted upon the truck.—*Le Genie Civil.*

IMPROVED PETROLEUM ENGINE.

THE engraving is a view of the petroleum engine by Messrs. Priestman Brothers, of Hull. The distinguishing feature of this engine is that it is driven by ordinary paraffin oil, the refined petroleum of commerce, which is used for lamps in millions of houses in all parts of the globe. Engines have previously been constructed which have used the lighter products of the distillation of petroleum, such as benzine, gasolene, and the like, but they have labored under the disadvantage of employing a dangerous explosive fluid, which the fire insurance offices often refuse to allow to be stored on premises covered by their policies, or at best only permit under an enhanced rate of premium. The ordinary paraffin, on the contrary, involves no such disabilities.

IMPROVED PETROLEUM ENGINE.

It does not give off an inflammable vapor under usual conditions at any atmospheric temperature, and it cannot be ignited in bulk. A lighted match falling into it is extinguished immediately, as if it had dropped into water. Paraffin can be bought in every country village and wayside hamlet in Europe, and indeed in all civilized parts of the world, and there is the prospect that its price will fall steadily in the future, as the various known sources of supply become opened. At present its price in this country is such that the cost of oil for driving the engine is 1¼d. per brake horse power. This is equivalent to the expense of running a gas engine with gas costing 3s. 6d. per thousand cubic feet.

As will be seen from the engraving, the general appearance of the engine resembles that of the Otto. The differences are principally matters of omission; we miss the well known slide at the back of the cylinder, the ingenious drop lubricators, and the hit and miss device of the governor. On the other hand, we have a pair of small pumps, driven from an eccentric, and inside the bed, out of sight, we have the oil tank and the means for vaporizing the fluid. There is also a galvanic cell and an induction coil for igniting the combustible mixture in the cylinder, and a contact arrangement for closing the circuit at the moment when the compression is complete.

The cycle of the engine is the same as that of the Otto, there being one explosion in each two revolutions. The pump at the side of the engine forces air into the oil reservoir, on which is a valve loaded to 5 lb. on the square inch. The air carries the oil with it in the form of a fine spray or mist into a heating chamber kept at a considerable temperature by a jacket in which circulates the products of combustion from the cylinder. Here the mixed air and oil are raised to a temperature of about 300 deg. Fahr., and are then drawn into the cylinder through a lift valve, together with more air to form the charge. This charge is compressed in the usual way, and is then fired by an electric spark. At the end of the working stroke the exhaust valve is opened and the products of combustion discharged. The engine is regulated by a governor, which controls the flow of oil from the tank. There are no lubricators on the cylinder, the charge acting perfectly in this respect, keeping the surfaces bright and smooth. The combustion is perfect, the whole charge being evacuated as gas, and none remaining as carbon to clog the cylinder or valves.

It is impossible not to admire the simplicity of the design of this engine. All the valves are of the lift type, and act, with the exception of the exhaust valve, automatically. There is no slide to be adjusted, and no external light. Once the engine is in action it runs without attention, and may be left for hours without an attendant, with the certainty that nothing can go wrong. Messrs. Priestman are elaborating designs for portable, tramway, and launch engines of this kind. For the first two of these purposes it will have the great advantage that it requires no water beyond the cooling water carried in the base, and which lasts for nine hours without renewal. The fuel also is much lighter than coal.—*Engineering.*

THE BUSSIERE DISAPPEARING TURRET.

In order to complete our study of turrets, which is one of great importance as regards the interests of the defense of the national territory, it is well to explain to our readers the general economy of the counterpoise accumulator disappearing turret. Colonel Bussiere, the inventor of this system, made it the subject of a memoir which, in 1871, was submitted to the appreciation of the committee of government engineers, and a review of which was printed in the 23d number of the memorial of the army. Later, in 1885, the inventor, who had changed and improved his ingenious arrangement, again presented the project of it drawn up in every detail of execution. For this a gold medal was awarded him in 1886. The Bussiere turret has, not without success, just been submitted to experiments at the camp of Chalons, and we cannot omit to mention the very brilliant manner in which it behaved.

But let us begin by giving a brief description of it. It has been learned by experience that, all things equal, a vertical wall is not sensibly more vulnerable than a cuirass held at any inclination whatever, and this observation has permitted the inventor to give the cuirass of his turret a cylindrical form. This cuirass, which measures 4 ft. in total height and 1⅓ ft. in thickness, consists of three sectors of mixed metal assembled by groove and tongue joints according to vertical generatrices. As for the roof, which is 9 in. in thickness, that consists of a disk in two pieces resting upon the circumference of the vertical cuirass, and fixed in a recess by means of strong screws inserted obliquely so as not to weaken the upper edge of the cylindrical wall. This roof has to be kept absolutely level, seeing that, being given its horizontality, it is no longer exposed to anything but the effects of vertical firing, which are much less dangerous than those of a direct firing, as has been demonstrated by the experiments of the polygon of Cotroceni.

The walls of the cylindrical well, inclosing the entire framework of the apparatus, are of beton and tufa. The upper part is protected by a curb of hardened cast iron or of cast steel, and this is prolonged by a glacis plate of curved armor plates buried in the beton. This plate is designed to protect the lower part of the masonry of the well.

The cylindrical cuirass rests upon a strong steel ring provided with a cushion of lead designed to assure an equal distribution of the weight and to diminish the force of blows. This ring constitutes the upper edge of a hollow steel plate ring forming a prolongation of the cuirass internally, and strengthened by uprights and horizontal braces. The highest of these latter constitutes the floor of the gun chamber and receives the gun carriages.

The guiding in a vertical direction at the upper part is effected by means of a circle of rollers provided with vertical axles sealed into the masonry of the well, and in which moves the ring that supports the cuirass. The centering of the directing rollers can be regulated, and they are consequently so arranged as to keep the turret in a perfectly vertical position. At the lower part, the pivot of the apparatus slides by slight friction in a socket carried by a metallic plate solidly set into the masonry.

A steel collar, whose position can be regulated, is arranged above the circle of rollers. The inner face of this, provided with a channel, allows the surrounding parts of the external face of the cuirass support to have a play of but 0·04 of an inch. This makes a joint tight enough to prevent the introduction of external gases due to the explosion of the enemy's projectiles or to the firing of the guns in the turret.

The total weight of the movable part of the work—cuirass, guns, men, and ammunition—is about 396,000 pounds.

This movable part is supported by a hydraulic press, whose cylinder is connected with the lower part of the iron plate pivot and is put in communication with a counterpoise accumulator by a system of piping.

This accumulator, which is designed to balance the greater part of the weight of the ironclad turret and to reduce to a minimum the motive work to be developed at the moment of putting the guns in battery or lowering the turret, and which is located in a chamber near the turret well, consists of a movable vertical cylinder of 11 in. internal diameter, ballasted by cast iron rings forming a load of 150,000 lb., and resting upon a differential piston whose rod is 10 in. diameter. The lower part of the latter is inserted in a disk which is sealed in the masonry.

The piston rod of the accumulator, which is hollow, puts the interior of the cylinder in communication with the interior of the press that lifts the turret. A second conduit, likewise inclosed in the piston rod, is connected with a valve-maneuvering apparatus that permits of establishing at will a communication between this conduit and the first, or to empty it. It follows from this that the weight of the movable part of the accumulator is distributed now upon the entire surface of the piston, 11 inches in diameter, and now upon the reduced surface of the rod, 10 in. in diameter. The pressure of the water contained varies between 30 to 50 lb. to the square inch. The corresponding stresses exerted upon the piston of the press are respectively 350,000 or 468,000 lb. in the static state.

In the first case, if the turret is in battery, its weight overcomes that of the accumulator, and it necessarily descends. In the second case, the immerged turret rises into battery under the preponderant weight of the accumulator. These maneuvers are effected from a post situated on a level with the ammunition floor, by means of hand wheels.

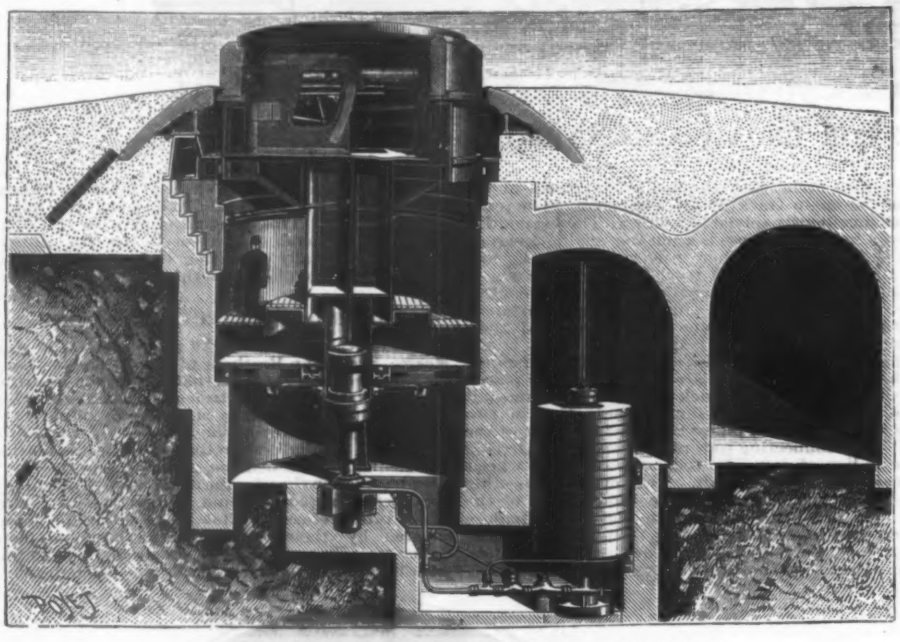
Such is, rapidly sketched, the essentially original part of the Bussiere turret, and the play of which permits of raising and lowering a large mass of metal almost instantaneously.

The travel of the turret from a position of rest to a position for firing is 30 in. The raising and putting in battery take together but an interval of seven seconds, and the lowering requires but five. Adding two seconds to the sum of these figures to represent the time of the order, we obtain a total of 14 seconds for the appearance of the metallic wall for firing the guns that it protects, and finally for its disappearance. The embrasures, the weak part of the turret, are often hidden four seconds after the firing has been done.

The rotary motion of the tower is obtained by manual power, steam, or hydraulic apparatus. It takes place only during the lowering, for the aiming is done under protection from the enemy's artillery.

In firing at a target composed of four panels, 19 ft. in height by 6 wide, at a distance of 9,100 ft., the Bussiere turret has struck the center 19 times out of 20.

In its turn, it has served as a target for guns that have not spared it, and attacking batteries have deluged it with blows, but it has valiantly supported them.—*La Nature.*



BUSSIERE'S DISAPPEARING TURRET.

[Journal of the Franklin Institute.]

BARNABAS H. BARTOL.

Barnabas H. Bartol, who died in this city upon the 10th of February, 1888, was one of Philadelphia's ablest engineers and one of the warmest friends of the Franklin Institute.

He was born at Freeport, Cumberland County, Me., October 31, 1816, the son of Barnabas Bartol and Rebecca, his wife, who removed, eighteen months later, to Portland, Me., where he became largely interested in shipping interests. In 1830, he removed with his family to New York.

The subject of this memoir was educated at a private school, taught by a Mr. Jackson.

On the 4th of March, 1833, being then sixteen years four months old, he was entered as an apprentice, until of full age, with Messrs. Kemble, who conducted a branch of the West Point Foundry in New York. It is said that his father wished him to enter the office and drawing room, but it was his own plan to become a regular apprentice, for the purpose of acquiring a thorough knowledge of the practice and details of the profession.

He thus exhibited at the outset a leading characteristic, which was illustrated during all of his subsequent career. In 1835, he was sent as an assistant to erect a coal-winding engine near Richmond, Va., and also in the same year to assist in the erection of water works machinery in the city of New Orleans. In 1837, while still an apprentice, he was sent in charge to erect the first beam engine on Seneca Lake on the steamboat Richard Stevens, and in the summer of the same year to the vicinity of Richmond, Va., to erect a winding engine in the coal mines. In both of these last mentioned works he was assisted by a fellow apprentice, W. W. Wood, subsequently of the United States Navy and Chief of Bureau of Steam Engineering.

Becoming of age, October 31, 1837, and free from his apprenticeship, he went to East Boston, with a view of engaging in business, but was prevented by the disastrous effects of the reduction of the import duties under the operation of the "Compromise Act" of 1833, which deranged business generally. He returned to the West Point Foundry, and in October, 1838, was sent to the island of Cuba to erect sugar machinery.

On his return in June, 1839, he found the New York branch of the West Point Foundry consolidated with the parent establishment at Cold Spring. About the same time, the engineer and superintendent, Mr. Charles W. Copeland, retired, being engaged by the navy department to design the machinery of the steam frigates Mississippi and Missouri. Messrs. Kemble offered the vacant position to Mr. Bartol, who was then not quite twenty-three years old. He accepted, and remained in their employ until September, 1847, when he resigned and removed to Philadelphia, to become the engineer and superintendent of the Southwark Foundry, then belonging to Messrs. Merrick & Towne, and subsequently to Messrs. Merrick & Son. In this employ and capacity he remained until January 1, 1867.

During this period many important works were executed by the firm, some of which were designed by him personally. Among them may be mentioned, as most important, the machinery of the United States ship Wabash, and the hull and armor plating of the United States steam ironclad New Ironsides, besides many other steamers.

His design submitted upon the invitation of the Chesapeake and Delaware Canal Company for competitive plans for supplying their locks with water was awarded the premium, and the work was executed from his drawings and under his supervision.

The work of the Southwark Foundry during his incumbency as superintendent was large, varied, and important. The knowledge of machinery for gas making possessed by the founder, Mr. S. V. Merrick, brought it many orders and contracts for building and extending works in the country. The contracts by which the firm became the exclusive agents of Mr. James Nasmyth, the inventor of the steam hammer, and of M. Norbert Rillieux, inventor of the famous "triple effect" system of boiling cane juice into sugar, brought to the establishment a large business from both directions, and to Mr. Bartol a large fund of varied experience, which was of great advantage to him afterward.

We have traced in detail the principal events in Mr. Bartol's career, while he was in a subordinate capacity, because of the striking lesson it presents of the success which attends the strict attention to duties and studies.

The spectacle of a young man under twenty-three years of age placed at the head of an establishment like the West Point Foundry, where he had lately been an apprentice, is a very remarkable one, and a proof of his acknowledged ability. His successful management, against the jealousies which his promotion would naturally excite, is the best proof of the moral qualities which he afterward exhibited.

On leaving the Southwark Foundry, Mr. Bartol vis-

ited Europe for six months with a part of his family, and inspected the French Exposition of 1867. On his return, he devoted himself to the management of the Grocers' Sugar House, an establishment built by him in 1859, being the first sugar house in Philadelphia to use centrifugal draining machines, and also to the management of the Washington (D. C.) Gas Light Company, of which he was elected president in 1864, and continued in that office until 1883, to the great advantage of the company. In 1872, he was elected a director of the American Steamship Company, and served eight years as chairman of the building committee.

During the war the President offered to Mr. Bartol the position of engineer in chief of the United States Navy, but, after consultation, it was decided that he would be of more use to the government by remaining in Philadelphia and completing the New Ironsides, and other vessels upon which he was engaged.

Mr. Bartol's connection with the Franklin Institute began soon after his arrival in this city. He served on the board of managers for three years, 1863, 1864, 1865. In 1880 he presented to the Institute $1,000 invested in city 6's. With his consent the interest was devoted to providing prizes of free scholarship to be given to those pupils of the drawing school who were most deserving. He always exhibited the greatest interest in the prosperity of the Institute, and was always ready to assist in promoting its welfare.

In 1851, Mr. Bartol published a treatise on "Marine Boilers," which was fully abreast the practice of the day, and contains full details of the boilers of the principal vessels afloat.

Mr. Bartol was married in 1842 to Miss Emma J. Welchman, originally of England, by whom he had four children, two sons and two daughters, who all survive him.

One who knew him intimately writes:

"The perfect harmony which always existed between Mr. Bartol and myself enabled us to work together without the slightest friction, and no disagreement ever arose between us during our long association of twenty years.

"Mr. Bartol's characteristics were: (1) Method and attention to details in managing the work, both in its execution, its shipment, and its erection. (2) Uncompromising discipline and control over subordinates, yet combined with a sufficiently affable manner; every one had confidence that while he would be kept up to the line of duty, he would be treated considerately. (3) A direct practical judgment—no room given for sentiment or imagination—the question at issue being decided on its merits and generally with accuracy.

"This judgment derived much of its value from his thorough mastery of details acquired during his early training. He saw what would be required, how it could be done and how soon, and decided accordingly."

Mr. Bartol possessed superior administrative abilities, coupled with untiring energy and perseverance and a comprehensive knowledge of his profession. These qualities, with evenness of temper and straightforward honesty, formed a combination rarely found, and fitted their possessor for the responsible positions filled by him, and brought success to the enterprises of a busy, well spent life.

W. P. TATHAM,
WM. SELLERS,
WASHINGTON JONES.

[Continued from SUPPLEMENT, No. 648, page 10351.]

THE APPLICATION OF ELECTRICITY TO LIGHTING AND WORKING.*

By W. H. PREECE, F.R.S.

LECTURE II.

I WANT to disabuse your minds of the idea that electricity is a prime mover in the sense we generally consider prime movers to be. It is nothing of the sort; it is simply an agent or a medium by which energy, such as I showed and described to you recently, can be passed through one of its stages. The first form of energy that I am going to call your attention to-night is of the character generally called work. It means something done—objects moved, resistance overcome.

In all these actions of electricity that I am going to show you—if an electric current, for instance, moves a magnet, a magnet moved will produce electricity; if an electric current, as I showed you recently, produces heat, heat in its turn will produce electricity, and so we have throughout the whole range of mechanics and of science this principle of reversibility introduced. For another instance, suppose we compress air or gas, the gas always reverses the action, and exercises a reaction precisely equal in amount to the action that caused the compression. Take a letter weight. If you want to weigh a letter, you do so simply by compressing a spring, and the weight of the letter is measured by the reverse action of the spring in pressing the letter upward. If you take a weight and lift it, wherever it may be, that weight is in a position to produce the reverse action. If we take two magnets or two currents of electricity and forcibly separate them, there is also always this reaction between them.

I will first of all once more refer you to the hand dynamo, which will work and produce currents of electricity that will enable me to produce on the table before you some effects. Last week I showed you how we could obtain heat. To-night, as some of the effects I want to show you are rather minute, my friend, Mr. Lant Carpenter, has undertaken to assist me by throwing upon the screen behind me certain pictures conveying more vivid ideas of what I want to express than if I were to attempt to do so with the small apparatus that I have on the table.

I want, in the first place, to show you what is meant by a magnetic field. We have now on the screen the projection of a steel magnet, it has been charged with magnetism, and as Mr. Carpenter now scatters over a glass placed above that magnet some very fine iron filings, you see that they arrange themselves in straight lines and curves, and when the glass is gently tapped, those lines all arrange themselves in a radial fashion, with beautiful symmetry, in the most wonderful way, every particle being directed by attraction toward the pole; one pole of the magnet only can now be seen, though, of course, every magnet has two poles. From that I want you to see how those lines picture to us the conditions of the space that surrounds every magnet, and in every single experiment that I am going to show you to-night, the currents that we obtain are currents due to the fact that we can force copper conductors to pass through what is called a magnetic field; the neighborhood of a magnet, such as you saw just now on the screen, is called a magnetic field. Whenever a copper conductor, such as the wire I now have in my hand, or a wire arranged in other forms, is caused to pass through a magnetic field, it becomes electrified, it acquires that condition which enables us to obtain currents, and to use those currents.

I will now show you that we can utilize currents produced by this hand dynamo to attract and repel particles of iron. You now see on the screen two poles of an electro-magnet; the difference between a permanent magnet and an electro-magnet is that the one is made of steel and the other of soft iron. The permanent steel magnet acquires and retains its magnetism for a long time, whereas in an electro-magnet the magnetism only exists during the time that a current is passing round the soft iron core. The picture shows the two coils of copper wire which, with their cores, form the electro-magnet. Mr. Carpenter places some iron filings on that magnet, and on raising it they simply fall off, because there is no power present to attract them. I now cause a current to pass, and the iron filings being presented, they are attracted, and continue so as long as the current is passing. The moment the current ceases, the filings fall. That experiment failed at first, because a loose connection of one of the wires had been made, and no current passed. Faraday once made a remark that an experiment never failed. He said, "An experiment never fails; something happens that requires further investigation!" In that experiment we have seen one of the simplest and most-interesting elementary experiments in electricity. You have now seen that in a magnetic field we have the production of certain lines of magnetic force, and that currents of electricity produce magnetic fields. I want now to show you that whenever a conductor is passed through a magnetic field, work is done upon that conductor, it receives a kind of reaction, currents of electricity are produced. Similarly, if the conductor be placed in the magnetic field and a current from another source be passed through it, it is urged to move in a certain direction. I am going to show you the instrument itself if I can, but Mr. Carpenter has a similar instrument in the lantern, and the experiment will be repeated before you in another and different form on the screen.

The fact that I want you to understand is that whenever we pass a current of electricity through a conductor in the neighborhood of a magnet, or in a magnetic field, it has a tendency to be moved or to rotate around that field in a definite direction. Here I have a horseshoe magnet; it is surrounded by a cage of copper wire, and through that cage I will cause a current of electricity to flow, and if my current is all right (we cannot always insure that currents will go right—there are a good many wires about this table) the experiment will succeed. If the currents do not go, we will find out why they do not go; if they go right, you will see these coils move. You now see that the coils are rattling round at a rapid rate. I take the current off, and they stop; I put the current on again, and away they go. There you have an illustration of the fact that whenever you have a conductor in a magnetic field, and the conductor is traversed by a current of electricity, it is always urged to move.

I ought to point out to you that here we have the basis of every single experiment I am going to show you to-night. A current of electricity produced rotation, as you saw, in that cage, and in this particular form that I want to show you on the screen you will see that rotation is produced in another way. You now see the apparatus on the screen. On the left and right hand side there are two upright columns, the poles of the magnet, exactly similar to the one I showed you on the table. Between those two poles there is an iron armature rotating on a center point, and that armature is enveloped at each end by a small coil of copper wire. When a current of electricity passes through that copper wire it magnetizes the iron bar, and the iron bar gets attracted and repelled by the two poles of the magnet, so that on my now putting the current on, you see, away it goes. The application of that principle has been carried out in the little apparatus I have here, called Froment's motor. This particular Froment's motor is used to wind a clock; in fact, it has only just been taken from a clock which, at twenty minutes past every hour, was wound up by a current of electricity actuating this motor. By its means the hand winding of clocks is dispensed with, and, supposing a battery will last for years, so the clock will keep time for years without one being troubled by the necessity of going round the house and winding up the clocks. In order to show you, in a pretty way, one effect of this rotation, I have, through the kindness of Mr. Apps, brought here a motor which works a disk on the front of which some vacuum tubes have been fixed. Here is an induction coil which will produce currents of electricity that pass through these vacuum tubes and illuminate them, and when, by means of the motor, I cause the disk to rotate, you see what beautiful optical effects the persistence of vision produces when you look at electric sparks passing through vacuum tubes filled with a very slight proportion of different gases.

In this room there is always a very pleasant reminiscence, and a grateful recollection, of one of our most distinguished chairmen, Sir William Siemens. There is no man who has done more for the practical application of electricity in this country; he brought this very subject before us on various occasions, and I thought I could not do better than throw upon the screen that speaking portrait of our much-missed friend.

I will now show you how electric currents can be used to produce rotation or to produce motion. The history of motors is extremely interesting; it commences in the year 1823, when Mr. Barlow, the father of the present well-known engineer, the engineer of the Tay Bridge, and past president of the Institution of Civil Engineers, showed how it was possible to produce rotation by means of currents of electricity. The great apostle of electricity, Faraday, in 1831, did the same thing; and in 1833, Ritchie produced that very instrument that I showed you; but as far back as 1839, there was a Scotch gentleman, of the name of Davidson, who thought that this principle was applicable to the drawing of trains on railways, and I have a slide, which Mr. Carpenter will now throw upon the screen, showing his locomotive.

You now see a picture of that machine, as used on the Edinburgh and Glasgow Railway, or rather, I will not say it was used, because I do not think it could have been used, but it was tried on that railway as far back as 1842. You see there were eight electro-magnets, through which currents were passed, and these rotated the wheels. The machine worked at the rate of nine miles an hour. Other distinguished scientists have worked in this direction. Jacobi, of St. Petersburg, about the same time, drove a boat on the river Neva by means of an apparatus very similar to Davidson's. Froment, whose apparatus I showed you, applied this principle to his workshops in Paris; the tools in his shop were worked by an exactly similar motor to that which I showed you just now. Motors are innumerable; I have on the table here models of all the various patterns. Here is a very well known motor, the invention of an American named Griscom; here is a motor, and I have no doubt, if I pass a current of electricity through the electro-magnet of which it is formed, you will see that it rotates rapidly, and works a fan. I will not dwell much on the various kinds of motors that are used. Mr. Immisch has distinguished himself very much in this direction, and I shall show you several of his motors at work. Mr. Parker, of Wolverhampton, has made one of the prettiest motors, and I shall show you it also at work. There is nobody who has done more for the practical application of this principle than Mr. Reckenzaun, and I shall show you his motor; and again, Dr. Hopkinson, as well as the house of Messrs. Siemens, have done an immensity to assist this application of electricity.

But I want to illustrate to you the property that the electric current has of transferring power from one place to another. We can produce power in this room, and we could, without difficulty, transfer the power produced here to Liverpool, to Edinburgh, or even to New York; there is absolutely no difficulty whatever in transferring from this very room energy produced by means of the dynamo machine, and sending it, if you like, to Kamschatka. Of course, the amount of energy you are able to transmit is quite another question; the amount varies very much with distance. Telegraphy is entirely dependent on the power which electricity gives us to reproduce mechanical effects at a distance. It would have taken a good deal too much time to have brought before you to-night the various systems of telegraphy; I will show you one, and that one of the earliest and simplest, the old A B C telegraph of Wheatstone. Here is one: it contains a little dynamo machine; when I turn the handle round I am converting the energy of my body into currents of electricity. Currents of electricity are produced by turning the handle, and I am able, by means of little finger keys (similar to the keys of an accordion) placed around the machine, to adjust or arrange the number of currents of electricity that go to the end of the table where the receiving instrument is fixed. As far as the apparatus is concerned, it does not matter whether the motor and receiver are separated by eight or ten feet or by eight or ten miles. You see by this power, we are able, in telegraphy, to transmit signals to any distance we like, and at any speed we like. I have mentioned that this power is used for winding clocks, and I will not refer to that again; but this power of transmitting energy to distances is used for a great many practical purposes. For instance, all of you who travel by railway—and I doubt whether anybody here does not travel by railway—are dependent upon this power of electricity to secure safety and to give knowledge of the approach and departure of trains. Sounds can be produced by striking blows, blows being the expenditure of energy, and here I have a bell which is struck by its hammer whenever I send an electric current through its magnet, and so I reproduce by the current an action similar to that of the elbow. But this same power that electricity gives us to reproduce energy at a distance can be used for purposes which some would be inclined to say are more useful than telegraphy. There may be some people who still look upon a telegram with an amount of horror, and when an envelope containing a message is handed to them, immediately turn pale and feel themselves rather affected; but, while many do not care about telegrams, everybody likes water. It does not matter to what class a person belongs, he indulges some time or other in water, and any apparatus that will facilitate the production of water will attract our attention. I have here the little Parker motor I mentioned, and a pump. When I send a current of electricity the motor works, and in its turn, by a pulley, works the pump. Mark you, the pump and motor are only a few feet from me, but it would be just the same if they were ten miles away. This simple system of pumping water by electricity is used to a very large extent. There are a great many people who employ electricity now, as I told you at our last lecture, to light their houses, and those who employ electricity to light their houses can employ the same currents and the same power exactly to raise water.

There is a friend of mine near East Grinstead, Sir Francis Truscott, who has his house fitted with electricity. He used to employ two men every day in raising water from a depth of 150 feet to fill his tanks, but when he had secured the use of electricity for lighting his house, I suggested to him that he might just as well use it for raising his water. It was no sooner suggested than acted upon. A little motor, not much larger than that you just saw, works for two hours a day, and supplies a full quantity of water for the house, and the services of the two men were dispensed with in that respect. There is no reason on earth why those people in the country who depend upon manual labor for the raising of water cannot raise their water with greater speed and more efficiency by means of an electro-motor; in fact, this is carried out to a very large extent in South Wales by Mr. Brain. In the collieries in the Forest of Dean electro-motors are used to a very large extent to raise water from depths of hundreds of yards, and through distances that approach from a mile to two miles. Well, the same power exactly that can be used to raise water can be used for many other purposes.

The present prime minister of England is a very advanced electrician. There is no man in England who has applied electricity so much for domestic and useful

* Two juvenile lectures recently delivered before the Society of Arts, London.—*From the Journal of the Society.*

purposes as Lord Salisbury has at Hatfield. He was one of the earliest in the field; he has at Hatfield currents of electricity which are not only used for pumping, but also for chaff cutting, turnip cutting, for sawing timber, and for many other farming and domestic purposes.

To-night I am also able to show you this operation of sawing by electricity. The same motion that you saw in raising water we will apply here. Through the kindness of our chairman, Mr. Anderson, we are able to show the arrangement we have here. At one end of the table we have an Immisch motor; it is so small that you can scarcely see it at a distance, it would go in a moderately sized hat, but it will, on a current of electricity going through it, develop three-horse power. It will set a pulley in rotation, that pulley has a strap on it which works the countershafting behind me, and from this countershafting there are bands that work two or three machines that I shall refer to directly. I now want to call your attention to the circular saw which has been lent us by Messrs. Churchill. Sawing in country houses like Lord Salisbury's is required for cutting up the timber required for fires and for many other purposes, and here we have, by means of this motor, the countershaft and the circular saw at work. Here also is a Singer sewing machine driven in the same way.

The next purpose that electricity is used for, to which I want to draw your attention, is that of the transmission or propulsion of coaches on railways. I have taken the trouble to find out the various railways and tramways in America, in Great Britain, and on the Continent that are now worked by means of electric currents. Here is a list of them:

that persons got shocks by stepping on one rail and touching the other. The paragraph ran as follows: "A rather mysterious affair has happened in connection with the insulated electric rail on the Giant's Causeway and Portrush Tramway. It appears that country people are in the habit of touching the rail and receiving harmless shocks, but on Thursday evening a plowman, returning with his horses, stood on the rail to mount. [Well, he could not; there was no rail to enable him to mount; the rail is on the wrong side.] Immediately on applying his hands to the horse's back, the brute fell dead against the rail. The strange part of the affair is, that the man was uninjured, although the current passed through his body to the horse." That is a sample of reliable history!

Now we will throw upon the screen a picture of an electric railway that was used at the Paris Electrical Exhibition in 1881. Exhibitions have been very celebrated for electric railways; there was one at Paris, another at Munich, at Vienna, Antwerp, Philadelphia, the Inventions Exhibition at South Kensington, and at Edinburgh, but the picture you now see is of that at Paris, which carried a great many passengers for a distance of about a third of a mile to the Electrical Exhibition there; the peculiarity of it was that the conducting wires were overhead, and the rails were not made use of as at Newry and Bessbrook.

Another application of electrical power tried at the Paris Electrical Exhibition was carried out by M. Tissandier, who attempted to navigate a balloon by its means. The balloon worked satisfactorily inside the exhibition building, but failed when tried in the open air, being simply carried away by the air currents, having nothing for the fans to work against. A good deal more is wanted to be known before we can possibly solve the difficulty of navigating balloons, and at present we are simply dependent upon currents of air to carry us from one place to another.

A very curious departure from the ordinary practice of conveying materials was started by Professor Fleeming Jenkin, who is, unfortunately, now no more, and he, in conjunction with Professors Ayrton and Perry, started a system called telpherage. There we have a picture of the telpherage system, introduced near Glynde, a station on the Brighton Railway. Not far from Lewes, a mile or a mile and a quarter from the Glynde Railway Station, in the Downs, there are certain clays which are valuable, and from the clay pits the clay is sent down to Newhaven for shipment abroad. This system of telpherage carries the clay from the pits to the station by means of electricity. Two heavy wires are fixed on cross beams, or posts, which pass over the meadows. They do not interfere with the roads or the grazing of cattle. They pass through bogs, marshes, rivers, and anywhere you like, and on these wires skeps—a kind of bucket—are carried on rollers, by which they pass along. Each skep carries about half-a-hundredweight of stuff. In the center of the picture you will see the motor, or locomotive, which is worked by electric currents generated at Glynde and transmitted through the wires. The arrangement is extremely ingenious, and daily and hourly trains pass by this means over the Downs to Glynde Railway station carrying the clay. Such is the telpherage system.

But there is one system of carriage where electricity is destined to become more useful and more valuable than any other that I have brought before you, and that is in the working of a system of tramways in towns. There are few people who know that the number of horses required to work a tramway is twelve per car. My figures are taken from Manchester, where there is one of the best worked systems of tramways that we have in this country. There every car requires twelve horses to work it; the life of a car horse on those tramways is only four years. Working tramways in the north, wherever there are heavy gradients, is really cruelty to animals. We know that a horse can only do a horse's work; there are some men who can do a good deal more than an ordinary man's work, but we rarely should expect any man to do more than five or six men's work. But these tramway horses are absolutely frequently called upon to do eight or ten times more than nature has constructed them to do, and it is no wonder that their life is so very short. This remarkable fact comes out in dealing with horses from a pure matter of fact point of view. If we work a tram car by electricity, by means of batteries placed in the car, taking the price of horseflesh and the price of batteries per ton, the cost is exactly the same—it requires a ton and a half of horseflesh, it requires a ton and a half of batteries to work a car. The life, as I stated, of a car horse is four years, the life of a battery is four years. A horse will hardly do more than thirty miles a day; a battery will carry a car for sixty miles a day; and, in fact, when we remember that for the price of two horses, for the life of two horses, we can work tram cars by means of electricity, then, when you think that it takes twelve horses, the mere question of £ s. d. will carry the day. There is not the slightest doubt that, when the matter is properly and thoroughly worked out in a practical manner, batteries can and will work tramways, and the day is not far distant when all our tramways in and about London will be worked by means of batteries, and the poor horses relegated to duties for which they are better fitted.

We will now go back to some of the other purposes, and the one purpose that I wish to refer to is the power that electricity gives us to utilize the waste powers of nature. Wind, tides, and falling water are to be found everywhere, and if they can be utilized economically, will certainly be so used. I have shown you, in the case of the Portrush Railway, how water power is utilized in this way. In the Bessbrook and Newry Railway water power is utilized in precisely the same way. At Craigside, near Newcastle-on-Tyne, Lord Armstrong is able, by means of the energy of a waterfall in his grounds, to light up his house and to do various other things. In France M. Felix has used this same property for plowing. You will see on the screen a picture of the way in which the power of electricity is so used.

Again, at the Paris Electrical Exhibition, there was a Siemens lift worked by electricity, by which people were raised from the floor to the gallery. Dr. John Hopkinson has also worked in this direction, and a drawing of his plans now appears on the screen. This system of lifts worked by electricity is utilized at the present moment in London at at least two banks, the River Plate Bank and the Bank of Rio Janeiro, for carrying books and bags between the various floors of the premises. This power of electricity is more easily applicable for lift purposes than almost any other.

There is an experiment which I wanted to show you earlier, and as it is rather a pretty one I will show it you now; it is the power that electricity has to draw or raise a weight. This was used by Marcel Desprez, in Paris, for an electric hammer. I have here a weight that will pass up through a coil of copper wire. When a current of electricity is sent through the coil, the weight is sucked up, and there you see, by means of electricity, I am able to produce blows, and it only requires more electricity and a heavier weight to produce the effects of a hammer.

There is another application of electricity that has been attracting a good deal of attention at Brighton. Mr. Volk, who has done a great deal toward the application of electricity down there (he has laid an electric railway along the beach), has started an electric dog cart. He has fitted a dog cart with batteries, and it goes bowling about Brighton without a horse. He, his wife, and daughter are to be seen taking their airing along the Parade in a vehicle that looks like a dog cart, but there is no horse in it.

I now show you a picture of an electrical tricycle, brought out by Professor Ayrton, which was at the Vienna Electrical Exhibition.

When I was last in America, Mr. Edison, who is one of the most ingenious men alive, gave me what he calls his electric pen. It is in the form of a pencil, but instead of lead the core of the pencil consists of a very fine needle, which has an up and down play of about $\frac{1}{16}$ of an inch, and by its movement backward and forward, caused by a little electromotor, the point makes small holes in the paper. I write "W. H. P." To take copies of what is written, I should simply rub an ink pad over the little holes, when I should have "W. H. P." printed on the paper, and could strike off as many copies as I liked.

The motor that Mr. Volk uses for his dog cart in Brighton is also used for ventilating. I have here a fan which is moved by an Immisch motor which rotates at the rate of 500 or 600 revolutions per minute. As I showed you before, this same power of electricity can be used for working sewing machines. This sewing machine is worked by an electromotor, and it must be a comfort to those who constantly use such machines for domestic purposes, as by the use of electricity much fatigue is prevented.

Electricity has been applied to boot cleaning, to knife cleaning, and there is no reason why it should not be used for churning. It can be used, as you have seen, for ventilating. It can be used for sweeping. The same power can be used for mowing machines and many other purposes. Sir David Salomons has devoted his whole life to scientific pursuits, and his house is fitted up with electricity. He has a workshop fitted up with all the latest and most perfect tools, all of which are worked by electricity. We are going at such a pace in the diminution of labor, that one of these days I should not be at all surprised to see that electricity will work the dirty iron ore from the mines of Bilbao into a magnificent ten inch gun, better than anything that the establishment at Woolwich has produced. For toy purposes we have lots of things on the table, ships, electromotive engines, zootropes, and all sorts of things worked by electricity, but they are for your merriment after the lecture, rather than for your instruction during the lecture.

A distinguished electrician has dispensed with waiters at the dinner table by the use of electricity. He has fitted a small electric railway on the dining table, along

ELECTRIC TRAMWAYS IN AMERICA.

The *Electrician and Electrical Engineer* gives the following list of electrically-worked tram lines now in actual operation in the United States.

Town.	Line.	Conductors.	Length of line.	System.
Appleton, Wis.	Appleton Electric Street Railway	Overhead.	4½ miles.	Van Depoele, 5 motor cars.
Asbury Park, N. J.	Lea Shore Electric Railway	"	4 "	Daft.
Baltimore, Md.	Union Passenger Railway Company	"	....	Daft.
Bellevue, Pa.	....	....	½ mile.	....
Binghamton, N. Y.	Washington Street and State Asylum Electric Railroad	Overhead.	5½ "	Van Depoele.
Denver, Col.	Denver Tramway Company	Conduit.	4 "	Short-Nesmith, series.
Detroit, Mich.	Detroit Electric Railway Company	Overhead.	2 "	Van Depoele, 4 motor cars.
" "	Highland Park Railway Company	"	3 "	" " 2 " "
Gratiot, Mich.	Gratiot Electric Railway Company	"	....	" " 1 motor car.
Ithaca, N. Y.	Ithaca Street Railway Company	"	....	Daft.
Kansas City, Mo.	Kansas City Electric Railway Company	....	....	Henry.
Lima, O	Lima Street Railway Motor and Power Company	Overhead.	6½ miles.	Van Depoele, 7 motor cars.
Los Angeles, Cal.	Los Angeles Electric Railway Company	"	5 "	Daft, 4 motor cars.
Mansfield, O	....	"	....	Daft.
Montgomery, Ala	Capital City Electric Street Railway Company	"	11 miles.	Van Depoele, 20 motor cars.
Port Huron, Mich.	Port Huron Electric Railway Company	"	2¾ "	" " 3 " "
Richmond, Va.	Richmond Union Passenger Railway	"	....	Sprague motors.
St. Catharines, Ont.	....	"	6 miles.	Van Depoele.
Scranton, Pa.	Scranton Suburban Railway Company	"	2¾ "	Van Depoele, 3 motor cars.
Wichita, Kan.	Wichita Riverside and Suburban Railway Company	"	4 "	" " 6 " "
Windsor, Can.	Windsor and Walkerville Electric Railway Company	"	1½ "	" " 1 motor car.
Woonsocket, R. I.	Woonsocket Street Railway Company	"	....	....

ELECTRIC TRAMWAYS ON THE CONTINENT.

Town.	Line.	Conductor.	Length.	System.	Power.
Amsterdam	Cortverloren Park	Overhead.	½ mile.	Siemens.	Steam.
Berlin	Lichterfelde (Berlin-Anhalt Railway)	Rails.	1·6 "	"	"
Brussels	Tramways	Nil.	....	Accumulators (Julien).	"
Charlottenburg	Spandauer Rock	Overhead.	....	Siemens.	"
Cologne	Tramways	Nil.	....	E.P.S. Accumulators (Huber).	......
Frankfort-on-Maine	Frankfort to Offenbach Railway	Overhead.	4·1 miles.	Siemens.	Steam.
Hamburg	Tramways	Nil.	....	E.P.S. Accumulators (Huber).	......
Hohenzollern	Hohenzollern Colliery (Upper Silesia)	Overhead.	½ mile.	Siemens.	Steam.
Vienna	Moedling-Hinterbruel (Austrian Southern Ry.)	"	2·8 "	"	"
Zankerode	Zankerode Mines, Saxony	"	⅛ "	"	"

ELECTRIC TRAMWAYS IN GREAT BRITAIN.

Town.	Line.	Conductor.	Length.	System.	Power.
Blackpool.	Blackpool Tramway	Buried central rail.	2 miles.	Holroyd Smith.	Steam.
Brighton	Brighton Beach	Rails.	1 "	Volk.	Gas.
"	Brighton & Shoreham Tramway	Nil.	4 "	Electric Traction Syndicate (Accumulators).	Steam.
Glynde	Glynde Clay Pits	Open.	1 "	Telpherage.	"
London	North Metropolitan Tramways (Stratford & Manor Park)	Nil.	4 "	Elieson (Accumulators).	"
Newry	Bessbrook & Newry	Raised central rail.	3¼ "	Hopkinson.	Water.
Portrush	Portrush & Bushmills	Raised side rail.	6 "	Siemens.	"
Ryde, I. W.	Ryde Pier	Rails.	¾ "	Siemens.	Gas.

You will see how greatly and how rapidly this great power that electricity gives us is being utilized for useful purposes. One of the earliest lines upon which the power was used was the Portrush & Bushmills Railway, in Ireland. Near Portrush there is that wonderful formation of rocks known as the Giant's Causeway, and in order to see this remarkable geological structure, people travel a distance of some six miles. Not far from the line of route between Portrush and the Giant's Causeway is a place called Bushmills, through which a river runs, and this river has a very pretty and at the same time useful fall of water, which is utilized to work dynamos, which transmit currents of electricity through an insulated rail alongside the track of the railway, to supply motive power to the cars. You now see a picture of the tramcar used; that is a plan of it; the other is a perspective view; the motor itself is shown in plan. You see the two electro-magnets, and the armature, or coil of wire, that rotates is in the center. The rotation of that armature is transmitted to the wheels by means of the chain gearing that is shown. This railway at Portrush has been the forerunner of a great many railways in different parts of the world, but the most complete and the most perfect railway of its kind has lately been carried out by Dr. Edward Hopkinson, Sir William Siemens' assistant in carrying out the Portrush Railway. I refer to the Bessbrook & Newry Electric Railway. Instead of showing you a drawing of this railway, Dr. Hopkinson has made and sent us a model; that model is fixed to the wall of this room by five brackets, on which the rails have been placed, and a coach. A small motor is attached to the coach. When I turn on the switch, you see, away goes the car along the railway, and on getting half way it passes a brass pillar, catches a switch, which reverses the current, causing the car to return.

I read once a rather curious paragraph in a Belfast paper about the Portrush Railway. It was supposed

which the courses are carried and removed as required, and you now see a picture of the arrangement on the screen.

The clipping of horses can be done by this electric power better than by the hand process, with less injury to the animal, and far better than the old singeing process.

Electricity is also used for propelling boats, and you see a picture of the Cygnus, a boat used at the Paris Electrical Exhibition of 1881; a little Trouve motor works the screw. Now you see a picture of the boat Electricity, and the rate at which these boats are propelled is pretty considerable. There is a diagram on the table of the electric launch recently tried at Havre by the French navy; it is not a very elegant-looking boat, but I believe it goes with great velocity, and gives satisfaction. I have had the pleasure of going up the Thames in an electric boat made for the Duke of Bedford, and I have been up the Danube in another electric boat. I am looking forward to the time when we may have electric boats on the Thames. It only wants some enterprising firm to establish machinery at charging depots at Teddington, Reading, and other places, to enable boats to be propelled by electricity.

All the applications of electricity that I have shown you have been by way of peaceful purposes, but the same power can also be used for the destruction of our enemies. I have here a miniature ship in a bath containing water. It represents a pirate vessel with its black flag and skull-and-crossbone ensign flying, sailing along seeking its prey. On the pan containing the water there are two marks, and when the boat gets between them I know it is in the vicinity of a submerged torpedo, and on sending an electric current the torpedo explodes, and blows up the ship and all its crew to destruction. That concludes the experiments that I intend to show you.

I have shown you various ways in which it is possible, by the proper utilization of electricity, to economize labor; but there is always this fear, that if too many means of economizing labor are introduced, it may lead to idleness and evil. Still, when labor is saved in one direction, it is given in another direction, and the result must evidently be beneficial in the long run.

I have brought before you some effects of one of the great powers of nature, and I have shown you in these two lectures, in a very rough and hasty manner, how it is applied to useful purposes. Every single purpose which I have shown you was in itself deserving of a lecture occupying a whole evening; but, however, to the best of my ability I have endeavored to bring these matters before you, and I have been assisted in them by the very generous way in which others have come to my help. My friend Mr. Lant Carpenter has helped me considerably; Mr. Probert, Mr. Heather, Mr. Davenport, and others have all assisted. Mr. Immisch and Mr. Binswanger have been kind in their loan of motors, and our chairman this evening has been the means of my carrying out several of the experiments, and others have come forward with a liberality that is really overpowering. I am only too glad to think that I have succeeded in keeping your attention together for these two nights, and, I hope, shown you something that you have never seen before, and which I trust may lead you to see a good deal more of in the future.

FIRE PROTECTION FOR FLOURING MILLS.

DOUBTLESS the average mill construction, as viewed from the insurance standpoint, is far from being perfect. That it will gradually improve and approach more nearly to the highest insurance standard is probable and to be hoped for. The problem for the owner of an old mill to solve, however, is not how to build a new mill so as to conform to insurance requirements, but how to get insurance for his present mill at as low a cost as possible. In other words, it is insurance, and not indemnity, that he is looking for, and for insurance at reasonable figures. It will therefore pay the owner of any mill to look after the little details in the present construction of his mill, trifling changes in which may lower the rate. A little attention in this direction will, in many cases, effect a material reduction in the insurance rate. A brick fire wall between engine room and mill is, in many cases, most conspicuous by its absence. It would cost but little, in comparison with the sum represented by the interest paid as extra insurance on account of the higher rate due to its non-existence. So in the matter of stand pipe and hose. A little expenditure in this direction will, in many cases, result in a reduced rate. The mill owner should not, however, make the common mistake of putting in appliances of this kind entirely inadequate to the purpose intended. We have seen in more than one mill stand pipes only 1¼" to 1½" diameter, with a length of common ¾" garden hose on each floor. This may do to amuse the boys with when new, but is of small account in fighting an incipient fire, no matter how insignificant. Nor is it much better to put in stand pipe and hose ample in size and couple them to a boiler feed pump or other source of insufficient water supply. In one case that has come under our observation, the stand pipe and hose were even larger than the insurance companies specify, and the fire pump was ample. When all in place, it was found that the water supply was insufficient to keep the pump at work more than two or three minutes. The large pump was taken out and the stand pipe coupled to the boiler feed pump. Such protection as this is scarcely worth the name. The mill owner should consider that the purpose of such devices is primarily to put out fires, and the reduction of insurance rates is a secondary matter.

From Mr. S. H. Seamans, secretary of two of the mutual companies which write insurance on flour mill property, we have obtained the following regarding fire protection for flouring mills:

"Mutual companies require casks of salted water, with two fire pails to each cask, on all floors above the first, in mills which they insure. Many companies require stand pipe and hose, and all companies make a rebate on insurance charges for such facilities of 10 to 25 cents in rate. The stand pipe should be of not less than 2½" in diameter, and it is desirable, by means of lateral pipes, to have several hose communications on each floor. The hose should be 1½" rubber-lined cotton hose, not more than 50 feet in length, and have nozzle attached ready for use, the whole connected with stand pipe and supported by good swinging rack. Hose of this light weight is much more effective than the heavy 2½" rubber hose in general use, as one man can easily handle it, while to properly handle the larger size requires two or more men. The heavy hose is generally coiled, and is liable to crack and become useless when needed, but with short lengths of light hose, hung on swinging racks, no such trouble can occur.

"Mutual companies were also the first and strongest advocates of the use of automatic sprinklers in flouring mills, and for such sprinklers, properly put in and approved, make a uniform reduction of 25 per cent. from rate before so protected. To obtain such reduction it is necessary to have two sources of water supply for the pipes and to have supply pipes of sufficient capacity to maintain a good pressure in pipes in case many sprinkler heads are open at once.

"Great care should be taken to see that all work is done in a proper manner and that false economy does not induce the use of supply pipes of small capacity, thus defeating the object in view, *safety from fire*."—*Milling Engineer.*

A TEN DOLLAR SUIT.

A CERTAIN Boston clothing house has been well advertised throughout the country by an allusion to it in the recent tariff speech of Congressman McKinley, in connection with the exhibition of a representative suit of all-wool clothes that is offered to the retail trade at ten dollars. This little episode in the speech of the distinguished congressman was intended to practically illustrate the beneficial effect of a protective tariff for the wool manufacturing industry of the country. As the Boston *Journal* has said, "The mere exhibition of that ten dollar suit knocked in the head three of the most popular free trade fallacies. These are: First, the fallacy that the price of a commodity is enhanced by the amount of the duty; secondly, the fallacy that though the American workingman receives higher wages than the European, the difference is made up by the higher cost of the necessaries of life; and, thirdly, that free trade would be a boon to laboring people by reducing the cost of clothing and other commodities." Some effort has been made, by those of free trade proclivities, to convince the public that the cloth of which this and like priced suits are made contains a large admixture of shoddy. The truth of the matter is that woolen goods are to-day manufactured and sold at one-half the price obtained fourteen years ago. We have seen, this week, some attractive overcoating cloths held by a manufacturer's agent at 87½ cents per yard that in 1874 freely sold at $1.67½ per yard.

In regard to the possibility of procuring at retail a well made all-wool suit at ten dollars, it is a very easy matter for one to satisfy himself on this point by visiting the clothing stores of any of the large Eastern cities. Such a suit would consist of a sack coat, vest, and trousers, for which 3¼ yards of 6-4 goods would be allowed, to cost the clothing manufacturer $1.65 per yard, 5 per cent. off 4 mos. This price, no one will doubt, will buy a purely all-wool fabric, of good, medium fine stock and well finished, weighing 17 to 18 ounces per yard. The cost of the cloth, then, is $5.10, to which might be added $3.16 for making, including labor, linings, buttons, etc., in all $8.26, leaving a profit of $1.74, from which, of course, business expenses must be deducted. The margin left for profit is clearly a small one, yet it is enough to show that the merchant is not trading at a loss. The low labor cost of making might possibly have to be obtained at a season of the year when trade was dull and piece work inactive. Only large retail clothing merchants could afford to do business at so small a profit, but it shows, nevertheless, that a good, well made, gentlemanly suit can be bought at a very low price. In order to import this class of goods of which a ten dollar suit is made, the foreign price would have to be less than 90 cents per yard, in order to compete with the domestic product.—*Boston Jour. Commerce.*

CELLOIDIN AS A MICROSCOPICAL ACCESSORY.*

By J. MELVIN LAMB, M.D., Washington, D. C.

THE patented article celloidin comes into the market in the shape of cakes, rather transparent, and looking like ordinary glue. Another form is in small shavings or chippings. This is made from the purest pyroxylon, by E. Schering, Berlin, is non-explosive, free from precipitates, and costs about 3 m. per cake.

Inasmuch as a cake dissolved will furnish material enough for embedding 100 to 150 average size specimens, it is, considering its many advantages, quite inexpensive.

It has great advantages for embedding many tissues, and for certain organs—for instance, the eye—results may be obtained which cannot be had by various other methods. To cut sections of the eye, an organ composed of tissues of such varying density, it is desirable to have an embedding mass in which the tissues may be kept in a fluid solution, without injury, until thorough saturation is insured, and which will maintain the various parts of the object in perfect relationship for cutting, and after sectioning.

For this organ, and for tissues that have no connection of parts—tissues that immediately go to pieces, so that it is impossible to distinguish the relationship of parts—this mass offers superior advantages.

The use of celloidin is a cleanly process, nothing further being required in its application than a few stoppered specimen jars and some corks for fixing the embedded objects for cutting. No amount of experience is necessary in its use to insure good results, and it is comparatively rapid in its action.

In other modes, wax and paraffin specimens must be kept in a molten mass over a water bath, maintaining the heat at a certain temperature for a length of time varying from six to twelve hours. Should the heat go above a certain degree, the specimens will be most likely ruined, and if, on the other hand, it falls below the required degree, the process must be repeated.

The celloidin solution permeates the tissues thoroughly, fixing the parts in their natural position, does not shrink the tissues, and the process can be discontinued at any time, or delayed any length of time without resulting in harm to the objects.

It is perfectly transparent, and sections so embedded may be stained and mounted with the embedding material, which takes the staining but faintly; and when a specimen is cleared and mounted, the faint tinging on the celloidin does not detract from the appearance of the section, or in any way interfere with its usefulness.

Celloidin solution is made by dissolving the chippings in an equal part of absolute alcohol and ether. To 4 oz. of the above, add sufficient celloidin to make one solution of a sirupy consistence; the second somewhat thicker. Unless kept thoroughly stoppered with ground glass, the solutions will thicken by evaporation of the solvents. A quantity of the solvent serves at any time to reduce the solutions to the desired fluidity.

Specimens should be brought from absolute alcohol and placed in a mixture of equal parts of ether and absolute alcohol for about six to eight hours, and then may be carried into the thinner solution.

Let most objects remain here for 24 hours; when they are to be removed to the thicker solution, objects can be safely left in either solution for an indefinite length of time, so that for delicate objects in which it is especially desirable to insure thorough saturation and fixing of the parts in natural relation, they may be left in the solution for some weeks previous to embedding.

I find the method of embedding by the use of a coil of paper about the cork troublesome, on account of the formation of air bubbles. The simplest and most effectual manner to fasten the specimens to corks is as follows: Soak the cork for a short time in absolute alcohol, then flow over the surface on which you embed a film of thin celloidin, letting it partially harden. Place the object in the position desired for sectioning by the aid of the amount of celloidin that will adhere to it from the vial. Let this stiffen slightly, then add, at intervals of a minute, a few drops of the celloidin (depending, of course, upon the size of the object) by allowing it to flow over the object and about the base of it. Repeat this until a fair amount is covering and supporting the specimen. By this means you have only the required amount of celloidin about the object to support it firmly, and not a large mass to draw the knife through. After a few moments a film sufficiently firm will have formed to hold the object in position. The entire mass is now to be placed in a jar of alcohol of 80 per cent. to harden—requiring 24 to 48 hours. If the cork is shallow and broad, no weights will be necessary; merely invert the object in the alcohol, and the cork will serve to float it and keep it immersed.

The mass is now ready for the microtome, and the blade should be flooded with commercial alcohol. After sections have been obtained, the embedded object can be returned to the 80 per cent. alcohol, when it can be preserved for future use.

In clearing sections avoid the employment of absolute alcohol (unless used cautiously) or clove oil, as these agents rapidly dissolve the celloidin. Sections so embedded are best cleared in creosote and mounted in xylol balsam.

* A paper read before the Washington Microscopical Society.

METALLIC ALLOYS.

A RECENT lecture at the Royal Institution was by Mr. W. C. Roberts-Austen, on the properties of certain alloys.

The lecturer began by speaking of the changes in the molecular state of bodies sometimes set up by very small causes, and he exhibited a warm basin painted inside with a saturated solution of platino-cyanide of magnesium. The bowl appeared to be warm and empty until he breathed into it, when it became of a crimson color, in consequence of the traces of moisture, taken up by the salt from his breath; when he again warmed the bowl to drive off the traces of moisture, the coating became once more colorless. Metallic tin, he said, will readily bend, but let it be alloyed with but a small proportion of arsenic, it becomes so brittle that a small bar of it can be broken by the hand; this alloy closely resembles metallic zinc in its physical properties. An addition of but $\frac{1}{10}$ or $\frac{2}{10}$ per cent. of tellurium to bismuth will alter the form of the crystals which the latter metal forms upon cooling from the melted state. Black and red sulphide of mercury are chemically the same, though differing so widely in appearance. Lead can be thrown down by electrolysis in such a condition that it will readily oxidize in air and turn yellow, and copper can be so thrown down electrolytically as to present properties differing totally from those which it exhibits under ordinary conditions. Sulphur and phosphorus may after melting be cooled down below their melting points without solidifying. He dropped a solid piece of phosphorus into some phosphorus so cooled down, and immediately the whole mass solidified. Somewhat the same phenomenon is presented by melted gold. He took some buttons of melted gold, allowed them to cool to a certain point, then touched them with a rod; the effect was to momentarily raise their temperature and make them glow, then they solidified. Joule, he said, had proved that when iron is released from its amalgam with mercury, it will take fire on exposure to the air, and that several other metals behave in the same way.

Aluminum and mercury, he continued, have normally little affinity for oxygen. His demonstrator, Mr. A. Haddon, here took a plate of aluminum, placed it in a dish, and began to rub mercury over it. After the lapse of several minutes, the surface amalgam of the two metals began to turn dead white in the air, and on inverting the sheet and tapping it, a small cloud of pure white clay fell from its surface. Next Mr. Roberts-Austen half filled a flask with powdered bismuth, lead, and tin, poured mercury, upon the mixture, and placed the flask upon a wet board. As the powders dissolved in the mercury, sufficient cold was produced to freeze the flask to the board. Mr. Spring, of Liege, had attempted to explain this phenomenon on the hypothesis that the metallic molecules so rearranged themselves as to occupy more space than before, and the act of expansion of the mass produced the low temperature.

The speaker next drew attention to a new alloy of platinum and gold upon which he had been working for some time. When thrown into water it took fire, and the gold is released as a black powder, differing from ordinary gold in its properties, for it readily forms auric hydride; by heating, it turns into a dull yellow powder, and by additional heating forms normal metallic gold. The Japanese, he said, had long utilized this abnormal form of gold, which they obtained from its

alloy with copper, with which latter they formed ornamental metallic designs upon knife handles and such things, and then released the dark-colored gold by a pickling process; by its means they had produced an appearance of transparency in a metallic representation of water, at a place where in the design a duck was represented plunging half its body below the surface of a stream. He believed that no other nation had made use of this alloy.

The changes which small proportions of foreign matter will produce in metals are not necessarily of small practical importance, for a small fraction of bismuth in copper will reduce its electrical conductivity sufficiently to cause any submarine cable made with it to become a commercial failure. A cable made of the copper of to-day has twice as much message-carrying power as a cable made in the early days of telegraphy, because of the copper now used being purer. Pure gold has a breaking strain of from 16 tons to 17 tons to the square inch; but when alloyed with but $\frac{1}{10}$ per cent. of lead it will break with a slight blow or under a trifling strain. He next exhibited an alloy of zinc and rhodium, which possessed in a small degree some of the properties of gun cotton.

DEODORIZATION OF SEWAGE.

For some time past, says a correspondent of the *Manchester Guardian*, the metropolitan public have been anxious to get at Sir Henry Roscoe's report on the deodorization of metropolitan sewage at the outfalls. At length a copy has fallen into my hands. The report is exceedingly interesting, and of vast importance to Londoners. It was a fortunate day that saw the appointment of Sir Henry Roscoe as consulting chemist to the Metropolitan Board of Works. During the short time he has held that post he has accomplished a considerable amount of valuable work. Sir Henry has made several experiments in reference to the deodorization, which it will be as well to set forth. A clear idea of the principles upon which the deodorants—bleaching powder and manganate of soda and sulphuric acid—act must first be obtained, as well as the subsequent changes which the sewage undergoes after such treatment in its passage into and admixture with the water of the river. No quantity of chemicals which can be added is sufficient to change the whole of the solid matter into harmless forms, so that the use of chemicals is only to be regarded as a temporary measure, guided exclusively by conditions of time and of place. Sir Henry points out that, considering the present position of the outfalls, the arrangements now existing there, and the conditions arising from drought and high temperature during the summer months, the addition of some deodorant to the effluent sewage is advisable; but should the conditions be altered, then the necessity for such addition might decrease or even disappear. The use of chemicals is only of value in so far that they either start a process of purification or simply get rid of the evil odor.

The knotty point is to purify the river (in which the sewage may remain for some length of time) by natural processes. Among natural processes the most important is the change produced by living organisms, and which is of two kinds. One is due to the action of organisms requiring free oxygen for their growth, and has the result of rendering the organic matter inoffensive; the other is due to the organisms which thrive in the absence of free oxygen and give rise to offensive products. The difficulty is to preserve the "healthy" organisms and to prevent the growth of those yielding offensive products. The oxygen required for the former of these growths is generally got from the air dissolved in all unpolluted running water. Now, sewage being free from dissolved oxygen, it undergoes a change of a putrescent character in its passage to the outfall, owing to the growth of the "unhealthy" organisms. The products of this putrefactive change absorb free oxygen, so that in coming into the river the water is deprived of its dissolved oxygen. If too much sewage is poured in proportion to the fresh water, the river is entirely robbed of its dissolved oxygen, thus practically doing away with the "healthy" growths. Adding deodorants does away with this putrescent material by chemical oxidation; but this only constitutes one step in the entire process of purification. The deodorized sewage has yet to be brought in contact with the free dissolved oxygen which is requisite for the respiration of the healthy organisms. Supposing the river water be insufficient in quantity, or that it has lost its oxygen by previous pollution, it then loses its power of supporting the life of the "healthy" organisms, and no amount of oxidizing chemicals will restore the river to its former condition. The only remedy will be the slow absorption of atmospheric oxygen at the surface of the water. Deodorization is valuable, then, that it is a means to an end, namely, to insure the presence of a sufficient quantity of free dissolved oxygen. Sir Henry Roscoe hopes in time to bring this about by the aeration of the sewage before it enters the river.

The report proceeds to set forth the action of the two deodorants—bleaching powder and manganate of soda acified with sulphuric acid. The relative oxidizing power of these two chemicals is that three grains of bleaching powder is equal to five grains of manganate. Experiments were carried on in order to ascertain which of these two chemicals is the more efficacious and safer to employ. In regard to the use of bleaching powder, Sir Henry Roscoe is not favorably impressed with the action of that chemical upon the general condition of the river. It was found that a quantity of bleaching powder equal to nine grains per gallon of sewage completely and permanently stops the growth of all organisms visible under a high power; that smaller doses, amounting to say three grains per gallon, appear for some time to exert an equally powerful effect; that the addition of one grain, though stopping the growth of certain organisms, seems scarcely to affect the growth of others. In using manganate for deodorizing sewage, the manganate is immediately destroyed, whereas the bleaching powder disappears but slowly, it being possible to detect it some days after its addition. Apart from the consideration of cost, manganate is more preferable as a deodorant than bleaching powder. The first series of experiments on the effects of the two chemicals on the living organisms contained in the sewage was carried out at Crossness, the remainder in Manchester. The average annual cost for using manganate as a deodorant is estimated at 40,000*l*.; the cost of sulphuric acid has not been taken into account. Even this outlay, however, will not suffice to prevent a foul condition of the river during the summer months. The only other feasible plan, in Sir Henry's opinion, is that of aeration, since free oxygen is to be had for nothing, and the cost of pumping air need not be considerable. Sooner or later we shall have to filter the sewage through land, or discharge it into the estuary at a point not higher than the sea reach. Until a more satisfactory means for overcoming the evil has been devised, it is proposed to add manganate in a moderate quantity—three grains per gallon—during those periods of the year when the dissolved oxygen falls below 20 per cent. of the possible maximum, or the chlorine exceeds 200 grains per gallon.

Such is the gist of this valuable report, to which is appended full details of the experiments, the quantities of deodorants used, and the rainfall returns.

HINTS ON THE RELIEF OF TOOTHACHE.*

There are four main causes of toothache: 1, irritation of the tooth pulp; 2, exposure of the tooth pulp; 3, periostitis; 4, alveolar abscess, or gum boil.

The first, irritation of the tooth pulp, is caused, as a rule, by caries, which starts at some congenital malformation, and is aided by the various acids engendered in the mouth, the result of disease or of fermentation of particles of food lodged in or between the teeth. The progress of the decay is no doubt also accelerated by various micrococci and cryptogamous growths. The decay creeps on till at last impressions of heat and cold or biting on a hard substance irritate the tooth pulp and cause pain of a more or less severe kind and duration.

In this species of toothache, the diagnosis could be arrived at by the following tests: no pain on tapping the crown of the tooth, no redness round edge of the gum, and the pain being only occasional and of a sharp character. Temporary relief would be afforded by a stopping, such as cotton wool saturated with a solution of mastic, or a plug of gutta percha to keep away cold and pressure, with advice to have a permanent filling put in.

The second variety, more frequently seen by pharmacists, is exposure of the pulp. The decay has proceeded till it has laid bare the pulp cavity, and any hot or cold substance or contact with any solid matter brings on an attack of severe toothache.

This form of toothache can be diagnosed by the severity and continuity of the pain of a sharp lancinating description, and little or no increase of pain on percussion; it is generally accompanied by extensive decay, and the gum may have a red ring round the margin.

Relief in this case may be obtained by introducing gently a plug of cotton wool saturated with camphorated spirit, camphorated chloroform, solution of cocaine, or any anodyne of that description; but of course these are only of a palliative description, and for permanent relief the pulp must either be destroyed or rendered healthy and a suitable filling introduced.

The third variety, periostitis or periodontitis, may occur separately or in conjunction with the two previous varieties, especially the latter. It is characterized by a deep redness of the gums, the tooth being a little longer than its fellows, dull heavy pain, very much increased on percussion, and the tooth is loose and may easily be moved.

In simple periostitis the remedy *par excellence* is "lin. iodi, tr. aconiti (Fleming), partes æquales." Dry the gum with a napkin, paint the affected part, and keep the mouth open till a metallic film of iodine appears, which takes place in a few seconds. If the periostitis is complicated with pulp trouble as well, this should be attended to as before.

In the last form of toothache, alveolar or gum boil abscess, the tooth pulp is always dead, and it is this dead and fetid mass that causes irritation of the tissues surrounding the apex of the tooth fang and formation of pus, which gradually increases and forces its way to the point of exit, generally the gum, though it often breaks in the cheek through injudicious external poulticing.

Among the poor, as a rule, the most practical plan is the extraction of the tooth, but if the patient can afford the necessary time, the tooth, as a rule, can be saved and rendered useful once more. Temporary and perhaps permanent relief (though not of a healthy kind) may be obtained by repeated poulticing inside the mouth (never outside) with a hot strong decoction of poppy heads and chamomile flowers, but as a rule it is kinder to your patient to send the sufferer to your dental brother.

MEMORY AND ITS DOCTORS.

Dr. E. Pick presents us with a brief but interesting *resume* of the "History of Mnemonics," with a short illustrative quotation here and there from some of the earlier works upon the subject. Most of the old authorities take figures—such, for instance, as the dates of historical events—as being about the most difficult things to remember, and attempt to facilitate their retention in the mind by substituting letters arranged in a particular order for the numerals from 0 to 9. These letter numbers having been duly learned by heart, some syllable is taken from the most important word, and added or prefixed to the letters representing the figures or date, in such a manner as to form a nonsense word, which at once recalls the event itself, and the time at which it took place.

Thus, according to the "Memoria Technica" of Dr. R. Grey, published more than a century and a half ago, supposing it were desired always to remember the fact that "the Deluge occurred in the year B. C. 2348," we find, on reference, or (if it has been previously learned) we remember the numerals just quoted may be represented by the letters e, t, o, and k respectively; prefixing to these the first syllable ("del") of the catastrophe in question, we coin the word "deletok," and, recollecting this, we remember all that is required.

The worst of these arbitrary methods of fixing, or attempting to fix, by a short formula, some longer and more complex fact or idea upon the mind, is, to our thinking, that hardly any two persons take up any psychic impression in the same way. Individual idiosyncrasies step in here, and what A finds the easiest thing in the world to remember may just be among the most difficult to B. We venture to assume, for instance, that no chemical student would dream of trying to fix the date of the deluge in his memory by so clumsy a device as that we have just quoted while he has a far simpler plan always ready to his hand, as we will endeavor to show. All he needs is the familiar "H_2O," and this once thought of in the proper way, it is simply *impossible* for it ever to be forgotten, as indeed we have proved among our young friends in numerous instances. Thus:

In "H_2O" the central (and, therefore, most distinctive) fact is the figure "2."

Of *atoms*, there are present exactly "3."

Picturing the formula in our mind's eye as a fraction, by the aid of an imaginary line of demarkation, $\frac{HO}{2}$ we get 2 multiplied by 2 (elements) = "4."

Next, the division of the atomic weight of O (16) by this same figure 2, gives us "8."

Lastly, the formula itself—H_2O—is permanently suggestive of the "deluge," and the whole (which occupies much more time and space in explaining it on paper than is required for the mental effort) is, once for all, indelibly impressed upon the memory.

We could easily multiply examples of this kind, tending to show that a chemist who knows his "symbols and equivalents" fairly well can therefrom construct for himself a far better mnemonic system than any he is likely to find elsewhere.

Returning, however, to Dr. Pick, his "new method of improving the memory"—which, by the way, is not altogether novel—chiefly consists in taking advantage of the correlation of what may be termed series of ideas, such, for example, as "book—printing; printing—newspaper; newspaper—telegraph; telegraph—Atlantic cable; cable—America; America—cotton; cotton—Manchester; Manchester—Sir Robert Peel; Sir Robert Peel—free trade," and so on.

But here again different people would instinctively forge very different links to the chain, when the whole "system" is at once weakened, and the item wanted would be missed and some other recalled to memory. Thus we might go easily from "newspaper" to *Times*; times—clocks; clocks—watches; watches—Sir John Bennett, etc.; cable might suggest "ship," or Sir R. Peel, "bobbies."—*Monthly Magazine.*

THE ENEMIES OF THE HUMAN SPECIES.

By Raphael Blanchard.*

The epoch in which we live will ever be memorable in the history of human knowledge. It has presided over the birth of a goodly number of sciences that were but yesterday unthought of, and in the first rank of which stands microbiology. This science, of which the illustrious Pasteur was the prophet, produced a profound perturbation in biology, and has revolutionized the physico-chemical world itself.

The fermentations that were considered but yesterday as taking place through the simple aid of chemical phenomena are nothing but the result of the vital activity of infinitely small organisms. Without them there would be no wine, no beer, no alcohol, nor many other liquors whose imbibition pleases man. Putrefaction, too, is accomplished under the action of microbes. The formation of vegetable soil and that of nitrates and humus are also under the dependence of these marvelous workers. Within the last ten years medical opinion has undergone a complete revolution by the very fact of the progress of microbiology. The old theory of germs or miasms has received a brilliant confirmation. Contagion exists, it is living, it is a microbe almost invisible to the strongest magnifications. Infectious diseases and others to which this character has been refused are caused solely by the penetration of a microbe into the organism and its multiplication either in the blood or the inmost organs. Progress has been so sudden and unexpected that we can already establish categories in all these animate contagions; fibrinous pneumonia and anthrax are caused by micrococci, charbon, lepra, and tuberculosis are due to bacilli, cholera is the work of a spirillus, and dental caries is that of a leptothrix.

Microbes are extremely small, but their domain is infinite, and has no other limits than those of our planet. The air that we breathe leads them into our lungs, the water that we drink introduces them into our intestine, and from thence they pass into our organism, and, actively developing, cause the various diseases of which they are the agents. They introduce themselves in the same way into the body of animals, and the flesh of these, if not properly prepared, is capable of transmitting disease to those who eat it.

It is therefore with liquid or solid food that the majority of these invisible enemies assail us. This mode of invasion is not peculiar to bacteria, for it is likewise through it that a large number of parasitic animals introduce themselves into our organism.

In this direction again medicine has in recent years made unhoped for progress. Although less brilliant than those briefly spoken of above, the results acquired in the domain of animal parasitism are none the less of a high importance, and it is such results that I desire to call your attention to.

THE ASCARIDES LUMBRICOIDES

is especially observed in children. It inhabits the small intestine, and lays eggs that are soon expelled. These are protected by a tough shell that preserves the vitellus from desiccation. The embryo does not begin to develop until the end of from five to eight months, provided the egg is in water or at least in earth or a damp atmosphere. After its formation, the embryo remains coiled up in the egg. At first, the animal displays active movements, which gradually cease, and only occur at long intervals. The embryo thus falls into a state of vital indifference which, as has been proved by Davaine, may last for five years. It finally dies and undergoes fatty degeneration, unless the shell that imprisons it has been led by drinking water into the human intestine. In this case, the digestive fluids soften the shell and set the embryo free in the medium that is precisely adapted to its ulterior evolution. It then develops and quickly reaches an adult state.

The mischief done by this worm is in most cases not

* From a paper by W. Rushton.

* Abstract of a paper read before the French Association for the Advancement of Sciences.

of a formidable nature, yet it is nevertheless capable of causing terrible accidents at times by getting into the air passages and causing rapid asphyxia, or rising through the choledoch duct and bringing about an icterus or suppurative hepatitis, or by perforating the intestine and falling into the peritoneum, or finally by causing nervous phenomena simulating chorea, epilepsy, etc.

This parasite is now comparatively rare in France. Is this because medicine has exterminated the race? No; it is simply due to the fact that the use of filtered water has become common.

THE TRICOCKPHALUS

differs much from the ascarides from a zoological point of view, but greatly resembles it in its propagation. This singularly shaped parasite lives in the first portion of man's large intestine. The eggs behave in the same manner as those of the ascarides, and develop only in water at the end of from six months to a year and a half. The embryo is introduced into the digestive passages by drinking water, and develops at once.

THE DUODENAL ANKYLOSTOMA.

This little nematode inhabits the small intestine. Discovered at Milan by Dubini, in 1838, and rediscovered in twenty per cent. of the inhabitants of Upper Italy, it was generally considered a harmless parasite until Griesinger, in 1851, found that to it was to be attributed the chlorosis with which half of the poor population of Egypt is afflicted. Later on, it was met with in Brazil in cases of opilation, and in the Antilles in cases of agueous cachexy, chthonophegia, and sickness of stomach among the negroes. "White tongue," earth eating and other morbid symptoms are connected with the presence of this parasite. Everywhere and always, those who harbor this parasite are enfeebled and are afflicted with profound anæmia. During the construction of the St. Gothard tunnel, a fatal epidemic arose among the workmen, who were struck by hundreds with anæmia, and the survivors remained for a long time debilitated and unable to work.

The cause of this remained unknown until one day in 1879, when Dr. Graziadei met with a large number of ankylostomas in the intestine of the body of a workman of the St. Gothard tunnel upon which he was making an autopsy. It was therefore necessary to attribute to these minute worms that terrible epidemic which made so many victims in a few months.

It has been found that this same parasite is the cause of the anæmia observed among miners and brick and tile makers in France, and workmen on rice plantations in Italy. In a word, the ankylostoma is one of the most formidable parasites of the human species.

An examination of the animal shows how it is capable of doing its mischievous work. Its mouth is armed with four strong chitinous teeth, by means of which it fixes itself to the mucous membrane of the intestine, which it perforates, and, reaching the capillary vessels, lacerates their wall. This abstraction of blood by hundreds of these animals for months debilitates the human organism to such a degree as to put life in danger and to make recovery very slow.

It is through water, and that alone, that this animal invades us.

FILARIA OF THE BLOOD.

Among the parasites transmitted to us by drinking water may be cited the filaria of the blood. This animal has not been known very long, since it was but twenty-five years ago that it was discovered by Demarquay. Nevertheless, its biological and pathogenetic history is already as completely elucidated as that of the best studied helminth.

One of the most widely distributed diseases in the intertropical zone is hæmato-chyluria; and the elephantiasis of the Arabs is observed in the same regions. It has been found that these maladies are but two manifestations of one and the same disease, which is due to the filaria. The circulating apparatus of persons afflicted with filariosis contains adult worms, which are about four inches in length. The females give birth to very small embryos, which are carried along by the blood and disseminated throughout the organism. From the blood, these embryos pass into the urine, into the tears, and even into the glands of Meibomius. Through the urine they easily reach water, and it was thus, it was first thought, that the migration necessary for their development was accomplished. But Dr. Manson, of Amoy, has proved by ingenious experiments that the embryo is introduced directly into the blood vessels by an animal in which it has to pass its larval existence, and that that animal is the mosquito. Countries in which filariosis prevails are infested with legions of mosquitoes. In certain species, the female is provided with a buccal armature strong enough to pierce the human skin. When, with this, she stings a slumbering man afflicted with filariosis, and sucks his blood, the embryos contained in the later pass into the insect's digestive tube, and, protected by their chitinous cuticle, continue to live and develop. When full, the mosquito goes off to some sheltered place to digest at her ease. The material absorbed serves for the elaboration of the eggs. When, after a few days, the latter are ready to be ejected, the insect repairs to the vicinity of a pond or brook, deposits her burden, and falls into the water and dies. Meanwhile the embryos have grown and have moulted several times, and thus reached their larval state. This state culminates at the very moment the mosquito falls into the water to which she has confided her charge. The larvæ are capable of leading a free and independent existence quite a long time, and consequently have an opportunity some day or other of reaching the digestive tube of man with drinking water. From the intestine they pass into the lymphatics and blood vessels, where they stop definitely and accomplish their last metamorphosis, which leads them to the adult state.

There is another species, the *Filaria Madinensis*, which is found on the coast of Guinea, in Senegal, Nubia, Arabia, Persia, Turkestan, Brazil, and elsewhere, which attains a length of six feet, and which appears under the skin and produces abscesses. The worm found under the skin is always a female, and is filled with an immense number of embryos that only await a chance accident to escape into water. When this occurs, the embryos fasten themselves to the feet of the cyclops that are met with in abundance in the stagnant waters of tropical countries, and, insinuating themselves between the abdominal rings of the little crustacean, enter the latter's general cavity. Here they remain, moult, grow, and reach their complete larval state.

THE LIVER FLUKE.

The liver fluke (*Distoma hepaticum*), so often found in oxen and sheep, is sometimes also found in man's liver. This is another parasite transmitted to us by water.

The worm contained in the biliary tracts of the sheep lays eggs, which, ejected from the intestines, finally reach water. Here they develop. An embryo makes its exit whose entire body is covered with vibratile cilia, thus making it resemble an infusorian. This embryo swims off to find some animal that can harbor it. Its intermediate host is a small shell fish, *Limnæa truncatula*, whose pulmonary chamber it enters. It then attaches itself to the side of this, traverses it, and enters the general cavity. Here it moults, and then undergoes complicated metamorphoses. It has now lost its ciliary appendages and is provided with a hollow cavity, in which are organized and developed cellular masses, each of which develops into a redic. The redics become free from the rupture of the side of the embryo's body and distribute themselves through the mollusk's body. They grow rapidly and give birth to a large number of new organisms, which accumulate in their general cavity. These creatures of the second generation are the cercarias. They have a disk-shaped body and a long tail. They make their exit from the redic through a peculiar orifice at the back. The animals are very agile. They make a passage through the tissues of their host and escape into the water. Reaching this, they swim with alacrity, using their tail as an oar, and then stop at the surface of some aquatic plant and encyst themselves. Swallowed by sheep or by man, they become transformed into flukes, and rise through the biliary channels to fix themselves definitely in the liver. They may get a lodging in animals in three ways: through eating the mollusk that harbors them, through drinking the water in which they are swimming, or by eating cresses on which they have encysted themselves.

THE BILHARZIA.

On the eastern coast of Africa, but especially in Egypt, there is frequently observed a peculiar disease known as hematuria of Egypt. It is caused by a worm allied to the fluke, but living in the blood. This worm (*Bilharzia hæmatobia*) is harmless in itself, but its eggs, which are armed at one end with a very sharp point, pierce the wall of the capillaries, lacerate the tissues, and thus produce intestinal or vascular hemorrhages. The metamorphoses and migrations of this parasite are unknown; but we know that it is transmitted by water.

THE LINGUATULA.

The linguatula lives in the nasal fossæ and the frontal sinus of the dog. It lays eggs which are ejected with the sanguinolent mucosities that the dog continually distributes over the grass, and which may be absorbed with the latter by an herbivorous animal or even by man. Soon after reaching the digestive tube, the egg gives passage to an embryo that traverses the wall of the intestine and encysts itself in the liver. Here it moults many times, each moult being the signal of a new organic complication. Finally it acquires a high degree of development. If the animal that harbors this larva becomes prey to a carnivorous animal, a dog for example, the larva enters the nasal fossæ, fixes itself therein definitely, and undergoes its last metamorphosis.

Owing to the fact that man is both herbivorous and carnivorous, he is capable of being the host of the linguatula in the larval as well as the adult state. There is a great difference in the frequency of these two forms, however. In fact, the adult has been recognized but once with certainty, while the larva has many times been met with in the liver and other organs.

TAPE WORMS.

We now come to the parasites that we owe to our animal food. The migrations of the tænias have been known for nearly thirty years. The *Tænia solium* comes from pork meat, the *Tænia vaginata* from beef, and the hydatic cysts result from fortuitous ingestion of the eggs of *Tænia echinococcus*.

The only important discovery that has recently been made in this line of research is that of the intermediate host of the *Bothriocephalus*. It was for a long time suspected that this worm, which is so frequent in Switzerland and the Baltic provinces of Russia, was transmitted to us by a fish, but there was a dispute as to the species. Prof. Max Braun has closed the debate and shown that the parasite passes its larval period in the muscles of the pike.

OTHER PARASITES.

We have just passed in review a certain number of enemies of the human species. Their nature is varied, yet all have a great resemblance as regards the manner in which they invade our organism. As for the microbes which we alluded to at the outset, these gain an entrance through our beverages or solid food. Now that their origin is known, it will be easy to protect ourselves against them, for parasitic diseases make a happy exception in the domain of pathology, in that their cause being determined, we know at the same time the measures to take to avoid them.

Since water is the vehicle of so many parasites, the exclusive use of boiled or filtered water is an imperious necessity. Ordinary filters are incapable of arresting the passage of the most subtile microbes, and these are not the least dangerous. Boiling prolonged for some minutes is alone capable of giving absolute security.

In regard to parasites such as trichinæ and cysticerci, whose germ is transmitted to us by solid food, prolonged cooking is the most efficacious of measures to take against them. Yet the usual culinary preparations are rarely sufficient to give absolute immunity. We know that trichinæ, for example, will live in pieces of meat immersed for some time in water heated to 80° C. Now, meat submitted to cooking never reaches such a temperature.

As regards parasites derived from vegetable food, we have no protection, herbs being mostly eaten in a raw state; but, fortunately, they form only the exception.

THE ACTION OF FLUORIDE OF SILICON ON ORGANIC BASES.*

By ARTHUR M. COMEY and C. LORING JACKSON.

THIS is an interesting paper contained in the May number of the *American Chemical Journal*, being contributions from the chemical laboratory of Harvard College. The authors say: The research described was undertaken in the hope of obtaining from the amines products similar to the compound which ammonia gives with fluoride of silicon, $(NH_4)_2SiF_6$, discovered by Gay-Lussac and Thenard † and three years later prepared and studied by J. Davy.‡ We have been able to find only two previous papers on the subject, one published by Laurent and Delbos,§ in 1848, in which the action of fluoride of silicon on aniline is described, the product being a nearly white mass, which they washed with ether, boiled with alcohol, and sublimed to purify it for analysis; their analyses, however, led only to a very complex formula containing oxygen, which they advance "with much reserve," although it was confirmed by the proportions‖ in which its factors combined. The substance when treated with water gave a gelatinous precipitate of silicic acid, and when boiled with alcohol was converted into small white lustrous scales.¶ The second paper was published by W. Knop,** in 1858, and had for its primary object the study of the solution of fluoride of silicon in absolute alcohol, which gave with urea and aniline the fluosilicates of these bases, both of which Knop sublimed, and obtained from the urea fluosilicate only ammonic fluosilicate, silicic acid, and cyanuric acid; but from the aniline fluosilicate a new substance, which gave a precipitate of gelatinous silicic acid with water, and contained more silicon and fluorine than the fluosilicate. He did not, however, identify it with the substance made by Laurent and Delbos. We may add that some years later W. Knop and W. Wolf †† describe the aniline fluosilicate more in detail.

The results of our work on this subject may be summarized briefly as follows: Aniline forms with fluoride of silicon a compound having the formula $(C_6H_5NH_2)_3(SiF_4)_2$, which sublimes without alteration, but is decomposed with water, forming aniline fluosilicate and silicic acid; when heated with an excess of aniline, it is converted into another compound having the formula $(C_6H_5NH_2)_4(SiF_4)_2$, and the same substance is formed when fluoride of silicon acts on aniline at high temperatures. This second product is unstable, breaking up spontaneously into the first and free aniline. The following bases also give compounds containing three molecules of the base to two of fluoride of silicon: paratoluidine, orthotoluidine, parachloraniline, diphenylamine, dimethylaniline, chinoline, and dimethylamine, the last giving also a compound having the formula $[(CH_3)_2NH]_4(SiF_4)_2$. On the other hand, we have not succeeded in obtaining from ammonia a compound of the formula $(NH_3)_3(SiF_4)_2$.

We propose to call these substances silicotetrafluorides, a clumsy name, it is true, but one which will designate them with certainty, whereas all the simpler names, such as silicofluoride or fluosilicide, have been used for the fluosilicates at one time or another, and might therefore lead to confusion.

The remainder of the paper contains the detailed account of our experimental results, and at the end a discussion of our views in regard to the constitution of the silicotetrafluorides.

SPECTRUM OF CARBON.

PROF. VOGEL communicated lately to the Physical Society, Berlin, the results of his researches on the spectrum of carbon. In recent times the spectra of all the carbon compounds have been recognized as being those due to carbon itself, the sole exception being in the case of cyanogen, whose spectrum was considered to be that of the compound, not of carbon itself. The speaker had therefrom investigated the spectrum of cyanogen, with the help of photography. He obtained a spectrum which was marked, from the red to the ultra-violet, by very characteristic lines. The spectrum of a Bunsen burner was next photographed, and it was found that its first three lines coincide in all respects with those of the spectrum of cyanogen; in addition a series of lines lying between the above and also in the blue were found to be identical in both spectra. On the other hand, the two bands in the blue and ultra-violet were absent in the spectrum of the compounds of carbon and hydrogen, being replaced by a series of very characteristic double lines. Prof. Vogel next photographed the spectrum of carbonic oxide, and found that its more highly refracted portion corresponded completely with that of cyanogen. The bands in the blue and ultra-violet were particularly well marked, whereas the less highly refracted half of this spectrum did not correspond with that of cyanogen. Finally, the light emitted by the electric arc was photographed, and its spectrum resembled, in all respects, that of cyanogen. The speaker drew the conclusion from these observations that in all four cases he was really dealing with the spectrum of carbon. The differences in the several spectra are not dependent upon differences of temperature, inasmuch as the temperature of a Bunsen flame is higher than that of cyanogen, and notwithstanding this the latter gave a more highly developed and complicated spectrum. The speaker was much more inclined to assume the existence of modifications of carbon, of which one yields its spectrum in the Bunsen flame, the other in the flame of carbon monoxide, the two spectra being met with united in those of cyanogen and the electric arc respectively. In photographs of the solar spectrum, the dark background on which the line G is conspicuous shows such a marked correspondence with narrow bands in all the above four spectra that the existence of carbon in the sun must necessarily be assumed.

* Communicated by the authors, from the Proceedings of the American Academy of Arts and Sciences.

† Mem. d'Arcueil, 2, 317.

‡ Phil. Trans., 1812, p. 352.

§ Ann. chim. phys., ser. 3, 22, 101.

‖ These proportions agree tolerably with the formula worked out by us for this substance, but their analytical results do not, and are entitled to no consideration, on account of the difficulties in the analysis, which Laurent and Delbos did not succeed in overcoming.

¶ Aniline fluosilicate.

** Chem. Centralblatt, 1858, p. 369.

†† Ibid., 1862, p. 401.

Prof. Vogel then spoke on color-perceptions, which he explained by means of experiments. It is well known that when a color-chart is seen illuminated by the light of a sodium flame, it appears colorless; the yellow appears to be pure white, and the other colors appear gray, graduating into black. This result is not observed with other monochromatic light, such as that of thallium or strontium. The speaker was, however, able to produce the same result by means of colored glasses, whether red, green, or blue; those colors always appeared to be white or very bright which most strongly reflected the light with which the color-chart was illuminated, all the other colors appearing to be either gray or black. When a second monochromatic light was added to a previous one, such as blue to a yellow light, then definite color sensations were observed, which increased in number when a third source of monochromatic light was superadded to the other two. Prof. Vogel laid great stress on the perception of white by monochromatic illumination of a uniformly colored field of view. He was not prepared to give any explanation of the phenomena, but simply to bring them to notice, with the intention of investigating them further.—*Nature.*

HOW TO CONSTRUCT A TABLE SPECTROSCOPE.

By A. F. MILLER.

A GOOD spectroscope is an instrument of great value to the student of physics or chemistry. Indeed, it is not too much to say that for many purposes it is absolutely indispensable. Unfortunately, the cost of such an appliance is very considerable, and it is on this account perhaps that but a small proportion of those having a theoretical acquaintance with its revelations and capabilities are familiar with its practical use. While spectroscopes are now found among the apparatus of all large colleges and schools, there are numerous workers, even among the students in these, who would find it of great advantage personally to have the uncontrolled use of such an appliance. There are many other workers too, outside scholastic walls, who while toiling at their ordinary avocations are devoting their perhaps scanty leisure to experimental science in various directions. To such often it is unknown that a really efficient and valuable instrument capable of use, not merely for *showing*, but for *measuring or mapping*, spectra may be constructed by any one of ordinary intelligence at a very small cost. But apart from economical considerations, the intimate acquaintance with the theory of the instrument gained by the *constructor* during the process of making is of no little value; as in this way he learns lessons and solves for himself problems never perhaps attempted by the simple user of the optician's highly finished "brass and glass."

In giving some account of a method which has in practice been found very efficient for arranging the component parts of a table spectroscope, it is not proposed to deal at all with the making of prisms and lenses. It is premised that these will be procured at once from a reliable optician, their cost being after all very little when compared with the price asked by dealers for a complete spectroscope of really no greater efficiency than the one now to be described.

The *soul* of the instrument, so to speak, resides in the prism. This should be of the densest optical flint glass procurable, with refracting angle of 60°, and should measure not less than one inch on the side. Three achromatic telescope objectives of 1⅛ in. diameter and 8 to 10 in. focal length will also be required. The small unmounted combinations kept at most large optical establishments to replace breakages in pocket telescopes will answer perfectly. Very little advantage is gained by procuring them ready fitted in brass cells, while the cost is a good deal increased. Only a simple method of fitting up the unmounted lenses will therefore be given; but should convenience point to the use of those already in cells, it will be easy to modify the instructions accordingly. The only other materials necessary are some brass tubing, sheet brass, and well seasoned wood—except indeed the ocular for the view telescope, which will be treated of in its place.

At this point we are to decide of what material the plate or *table*, to which all the other parts are attached, shall be made. Brass is very efficient, indeed the best; but its use will necessitate two or more patterns, castings from them, and metal work in the lathe, for which every one may not be prepared. For convenience joined to simplicity and cheapness, however, nothing can surpass a wooden plate, and we will suppose these advantages as deciding the selection in its favor. For this purpose a disk of well seasoned cherry or mahogany, A A, Fig. 1, is to be turned up 4 in. in diameter and $\frac{7}{16}$ in. thick. A slightly ornamental beading round its periphery as indicated relieves the appearance of undue thickness. When made it should forthwith receive two or three coats of thin shellac varnish.

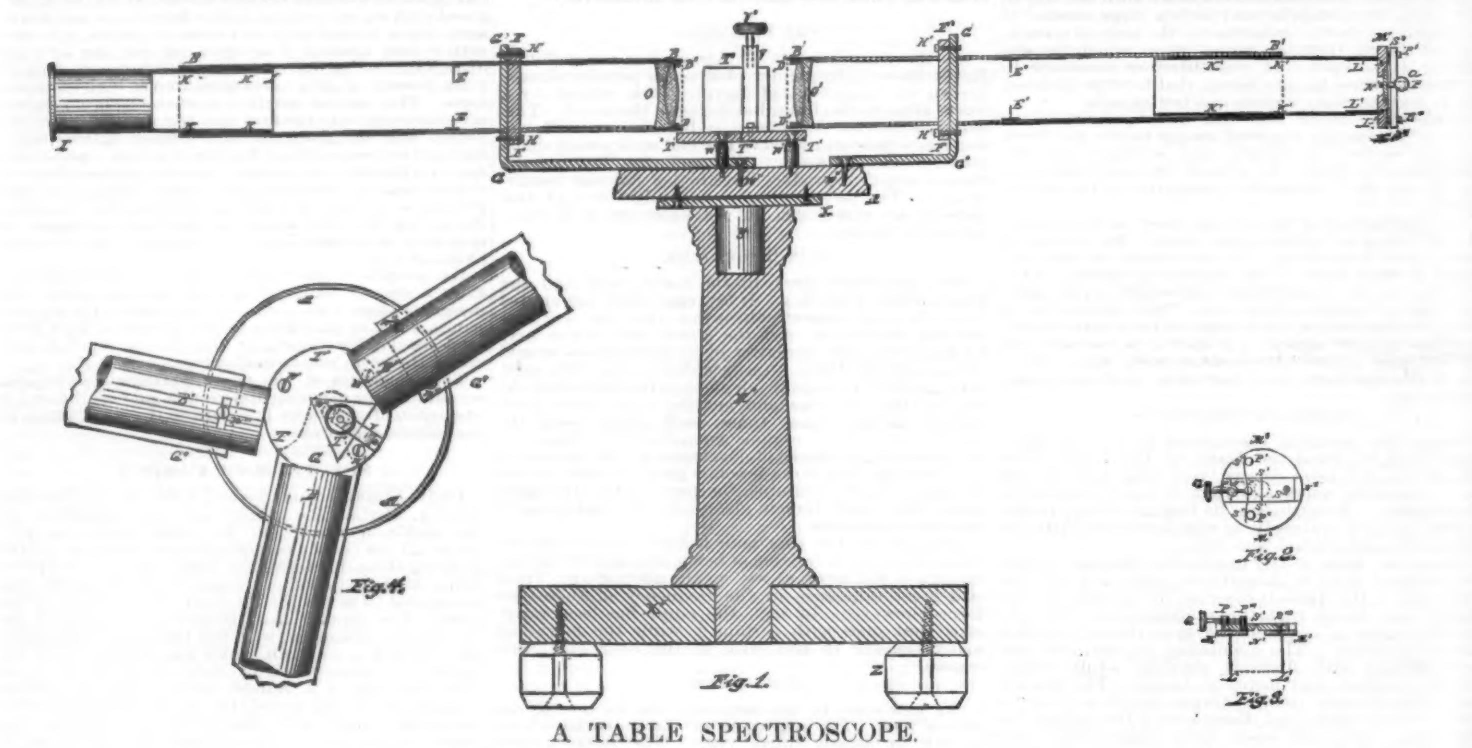
The three objectives, two of which are shown at O O', Fig. 1, are next to be mounted in small "telescopes." To do this, the solar foci of the lenses being noted (by holding them in sunlight before a card and measuring the distance at which the image formed is smallest and sharpest), some brass tube is selected of external diameter slightly larger than the glasses, while the interior diameter should be a little less, and three pieces cut off, each being about 1⅛ in. shorter than the focus of the lens it is to contain, B B, B' B', Fig. 1. If the tubing has been well chosen, it will then only be necessary to ream out a space at one end of each of these bodies to a depth slightly exceeding the thickness of the objective, and giving an internal diameter just sufficient to readily admit the same (as at B B', Fig. 1). These recesses, when truly made with a square internal shoulder, form convenient cells for the reception of the lenses, O O', which, when introduced (the concave member first), are retained in place by brass rings, D D', fitting tightly to the front of the cells. Such rings are cut from a short length of tubing similar to that used for the telescope bodies, the diameter of which has been reduced by slitting it longitudinally with a fine hack saw, bringing the edges of the slit together by a wrap of tightly twisted wire, soldering up the slit, and then cutting off three narrow bands for the rings, which, after a little fitting, will readily enter the front of the lens cells and hold the objectives fast. By this arrangement the lenses are quite well collimated, and very little of their effective aperture is cut off. A *draw tube*, I I, I' I', for each body will now be necessary. Each may be 3½ in. long. Sometimes mandrel-drawn brass tubes can be had in sizes which conveniently slide within one another and only need a little polishing to make them work with freedom. But should such not be readily procurable, an actually better sliding joint can be made from a strip of woolen cloth selected of proper thickness to just enter the larger tube when wrapped around the smaller. Such a cloth band, K K, K' K', fixed in the end of each body tube remote from the objective cell by means of a few drops of warm glue to which a little acetic acid has been added, makes a slide for the focusing tube at once smooth and firm in working and perfectly light-tight. At this juncture the interiors of all the tubes are to receive a coat of dead-black made by rubbing a little lamp-black with a few drops of gold size and thinning with turpentine till suitable for application. At a later stage the exteriors may be polished and lacquered according to taste. Each body should also be provided with an internal diaphragm, E E, E' E', of blackened cardboard having a central aperture large enough to admit the whole cone of rays from the objective while yet cutting off scattered light. The diaphragms are most conveniently placed by gluing each into a cardboard ring just capable of sliding tightly into the tube.

The telescopes are prepared for mounting by fitting each into a disk-like ring of $\frac{3}{16}$ sheet brass, F F, F' F', 1½ in. in external diameter and provided with a central aperture just admitting the body tube, to which it is soldered 2⅜ in. from the objective end. Two small holes are drilled through each of these disks at H H, H' H' on opposite sides of the central aperture and midway upon the flat surface. These are tapped and fitted with small screws of any convenient thickness and about ⅛ in. long, which serve to attach the completed telescopes to their supports by entering corresponding holes drilled and tapped therein, and also to adjust them in the same visual plane.

The attachments of the telescopes to the table are next to be considered. At this point select one of them definitely as the "view telescope," B B, and if there be any difference in their focal length, the longest should be preferred for this office, while the shortest is reserved for the "scale," Fig. 4, B'' B''; the other becoming the "collimator," Fig. 1 or 4, B' B'. For the support of the view telescope, take a strip of ⅛ in. sheet brass, G G, 6 in. long and ¼ in. wider than the diameter of the body tube. This is bent at right angles so that one arm measures 4 in. and the other 2 in. An aperture is made through the shorter arm a little longer than the body tube, and so placed that its circumference shall fall exactly ⅛ in. from the exterior of the rectangular bend (at the lower G, Fig. 1). At $\frac{3}{16}$ in. from the other extremity a ⅛ in. hole is drilled through the middle line of its surface and countersunk for the head of a small wood screw, W'', thus providing for its final attachment to the center of the table. 1¼ in. of the longer arm on each side of W'' should now be reduced to ¾ in. in width and rounded at the extremity as appears at G, Fig. 4, so as to admit of free angular motion between the stage pillars, W'. The collimator support, G'G', differs from the one just described only in having both arms of equal length, 2 in. The end by which it is attached to the table, A A, is drilled and countersunk at each corner for the wood screws, W''', Fig. 1 or 4, which hold it in place. The scale support, G'', Fig. 4, is the same as the last described, but the aperture for its attaching screw takes the form of a slot, W'''', Fig. 4, ½ in. by ⅛ in., the object of this arrangement being to permit of certain adjustments which will be found necessary in use.

An adjustable "slit" must next be provided. For the slit-plate a piece of carefully flattened ⅛ in. sheet brass, M'M', Figs. 1, 2, 3, is cut into a circle 1¼ in. in diameter and perforated with a central round ¼ in. aperture, N'. Concentrically about this orifice a ½ in. length of brass tube, L' L', is soldered, of such diameter as just to slip into the draw tube of the collimator. The opposite face of the brass disk is to have a slot or groove, N'', ⅜ in. wide and $\frac{1}{16}$ in. deep cut diametrically across its surface, traversing the central hole. The sides of this slot must slant inward, so that its width shall be greatest at the inner surface, as shown, with the object of retaining in place the two sliding "jaws" of the slit, S', Figs. 2, 3, which are to be capable of horizontal motion within the groove. For these latter, a piece of $\frac{1}{16}$ hard brass 1 in. long is carefully fitted to work as smoothly as possible to and fro in the slot, in which it is retained by its edges, which are made to slant in coincidence with the sides of the slot. When this piece has been fitted so as to work with perfect freedom yet without shake, it is to be withdrawn and its back (*i. e.*, the surface coming in contact with the bottom of the slot) marked in the middle with a perfectly vertical line. With a fine triangular file it is then cut through upon this line so as to produce two movable portions or jaws with chisel-shaped "knife edges." The knife edges must be worked as truly straight and smooth as possible, since any little irregularities upon their surface will be magnified by the refractive power of the prism into broad dark bands traversing the spectrum horizontally, to the great detriment of the instrumental definition.

It is not easy to suggest the best method of arriving at this result. A piece of very fine, smooth slate with water will remove the roughness left by the file, after which a very fine "slip" with oil, and lastly perhaps a piece of plate glass with rouge will, with proper skill, give a passable degree of clearness. A good result here will, however, most likely come only as the reward of patience after several trials. The finished jaws are to be replaced in their slot with the bevels of the chisel edges inward, and caused to meet just over the center of the slit-plate aperture, S' (Fig. 3). Hereafter it will suffice that one of them shall be capable of motion, so the other may now be secured in place by a small screw, S''', Figs. 2, 3, passing through it into the slit-plate. The movable jaw must have screwed into it a small upright brass pillar, P''', about ⅛ in. in diameter and ¼ in. high. Two similar pillars are also screwed into the slit-plate at P' P'', their office being to sustain a small piece of watch spring, S'', which by its pressure upon the pillar of the movable jaw tends to draw this



A TABLE SPECTROSCOPE.

back and open the slit. This action is opposed by the delicate milled-headed screw, Q, which works in a direction parallel to the plane of the slit-plate, passing at right angles through a fourth pillar, P, screwed down into the slot of the slit-plate behind the movable jaw, in which a rounded notch, N″ (Fig. 2), is filed to avoid catching on the pillar, P. By turning the milled-headed screw, Q, the slit can be closed to any extent, while the spring, S″, reopens it as the pressure of the screw is relaxed. The pillars, P′ P″, should each have a small slot filed at the point where the spring, S″, presses, while a slot cut down into the head of the pillar, P‴, receives the middle of the spring and holds it steadily in place. The finished slit is attached to the collimator by slipping the ½ in. projecting tube, L′, into the draw of the latter.

The scale is employed for the measurement or mapping of spectra, and consists simply in a photographic reduction of any selected scale of equal parts. It may be mm. or inches and parts. Whatever one be adopted, a portion of it, say 10 in. long, should be drawn with the divisions and numbers very clearly shown in ink upon a strip of paper 1 in. wide. From this latter a negative on glass is to be made, the reduction being just sufficient to bring the length of the photographed image within the internal diameter of the scale telescope draw-tube. The end of this latter is fitted with a brass disk of the same size as that employed for the slit-plate, and furnished like that with a central aperture, which in this case, however, may be as large as the draw tube, which, passing into it, may be fixed in position by soldering. A small square portion is to be cut from the negative plate in such a manner that the scale shall occupy the middle, while a sufficient margin is left round it to permit of its attachment by means of a little acetic glue to the brass disk just described. The scale is so placed that its center coincides with the axis of its supporting telescope. All that portion of the glass plate not occupied by the scale is to be covered with tin foil carefully pasted on so as to leave the latter only visible in the midst of a narrow slit; the object being to exclude all light except that which enters through the divisions of the scale.

The stage, T′ T′, for the prism, T, consists of a circular plate of $\frac{3}{16}$ inch brass, 1½ inches in diameter. It should be as flat and true as possible. It is well to accurately mark its center, and drill there a very small hole, T″. A diametrical line should also be inscribed across its surface with a graver and straight edge. At one of the points where this diameter meets the circumference the prism support, V, is to be screwed down to the stage, or it may even be soldered on. This support is of ⅛ inch sheet brass bent twice at right angles. Its free arm is drilled through and tapped to carry the milled-headed screw, V′, used to retain the prism, T, in position. The height of the support, V, should be sufficient to leave ¼ inch clear space between its upper arm and the top of the prism. The stage, T′ T′, is secured to the table, A A, by three brass wood-screws, W′, the holes for which are drilled in the positions indicated in Fig. 4, W′, so as to leave room for the angular motion of the view telescope support, which, when the instrument is put together, passes between the screws in the largest free space. A very simple and most efficient arrangement for leveling the prism stage is thus contrived. Three strips of thin sheet brass, each one inch long and about ¼ inch wide, are made to wrap, with a small degree of spirality, round the supporting screws, as shown at W′ W′, Fig. 1. When the screws are passed through their appropriate holes, then through the little brass tubes thus provided, and lastly screwed down into the table, the pressure of the spiral coils keeps the stage perfectly steady, while by tightening or relaxing the screws, W′, to a small extent, the level of the stage and thus of the prism can be adjusted with very great accuracy.

The pillar, X′, should be turned out of cherry or mahogany and may conveniently have a height of 6 inches. At Y, a hole is bored to a depth of about 1 inch. In this should fit tightly a 1 inch length of brass tube about ¾ inch diameter. This again is soldered round the center of X X, a plate of ⅛ inch brass about 2¾ inches in diameter, fixed by three or four small brass wood-screws to the underside of the table, A A, thus serving as its attachment to the pillar, X′. The foot, X″, is of tripod form, and may be sawed out of a piece of dry cherry. It has a central hole for the dowel or projecting end of the pillar, X′. The three extremities of the tripod rest on feet, Z, only two of which are represented. These may be conveniently cast in lead round common wood-screws, which serve as their attachments to the tripod, and also answer for leveling the complete instrument.

It only remains to refer briefly to the eyepiece for the view telescope. Instructions for making eyepieces have already appeared in this journal, and it is not proposed to repeat them here. Any astronomical ocular of low power may be adapted to the eyetube, II; but if there be a choice, the *positive* or Ramsden's form will give the best result as regards flatness of field. One having an equivalent focus of about 1½ inches will be found very suitable.

A few words will be necessary as to the assembling of the various finished parts and their adjustment. In Fig. 4 the arrangement of the telescopes and prism is shown. The collimator, B^1, should first be attached to the table, AA, by the screws, W‴, passed through its support, G^1. Its optical axis should coincide with a diameter of AA, being directed to the center of the table. Place a small spirit-level on the table, AA, and level the latter by turning the feet, Z, Fig. 1. Apply the level to the collimator tube, and bring the bubble central by turning the screws, H^1, Fig. 1. Focus the view telescope, B, upon any very distant object, say a star, and attach to AA by the screw, W‴, which must not be made so tight as to preclude motion round it as a center. Bring the view telescope opposite to the collimator, direct the slit toward the sky or other source of moderable illumination, and by means of the collimator draw-tube focus till the slit appears as a fine bright line in the field of view. If it should be too high or too low, bring its image central by means of the adjusting screws, HH, in the view telescope support. Place the prism stage approximately in the position shown at T^1 T^1, Fig. 4. Put the prism under its support, V, and secure it by the screw, V^1, interposing beneath the point of the latter a small disk of blackened cork or leather for the protection of the prism. Ascertain that the support, G, has room to move between the screws, W′; put the brass spirals round the latter under the stage, and screw down into the table, AA. Turn the slit toward any source of light, and move the view telescope till the spectrum appears in its field; if not centrally placed, bring it into position by turning the screws, W^2. Place the scale telescope in such a position that its axis makes an equal angle with the view telescope at the last surface of the prism; put a candle flame before the scale, and the latter should appear by reflection in the field of view, otherwise move the view telescope a little till it does appear, and attach to A A by the screw, W⁗, passing through the slot in its support. Since every change in the position of the prism will necessitate a corresponding alteration of the scale telescope, the slot is designed to admit of such adjustments, and therefore the screw, W⁗, must not at first be clamped too tight. The reflected image of the scale must be made to appear just over the spectrum by means of the scale telescope adjusting screws corresponding to H and H′. The spectrum will most probably appear inconveniently broad, and its width must be reduced by placing a diaphragm of black card with a one-eighth inch central aperture just behind the slit in N^1. If the spectral lines should not be seen truly perpendicular, the slit-plate must be revolved a little till they have their proper position. The instrument will give the best result only when the prism is placed at the angle of minimum deviation for the particular rays under study, but for directions on this point the reader must be referred to some of the standard works on spectroscopy.

CENTRAL ASIA—MOUNT GODWIN AUSTIN.

AT the meeting of the Royal Geographical Society lately held at the London University, Burlington Gardens, Lieut. F. E. Younghusband, King's Dragoon Guards, read a paper on "A Journey across Central Asia, from Manchuria and Pekin to Cashmere over the Mustagh Pass." In the course of the paper he said that he had been accompanied in his journey by Mr H. E. M. James, the author of "The Long White Mountain." On the day after he left Pekin, he passed through the inner branch of the Great Wall. There, under the eyes of the Emperor, it was a magnificent structure, built of immense blocks of granite. It was some 40 or 50 feet in height and wide enough at the top to drive two carriages abreast on. After passing through the Great Wall he entered what Marco Polo called the land of Gog and Magog. For the next two days he passed through a hilly country inhabited by Chinese, though it really belonged to Mongolia, and soon afterward emerged on to the real steppes, which were the characteristic features of Mongolia proper. Stretching far away in the distance there was a great rolling grassy plain, on which the flocks and herds and the yurtas or felt tents of the Mongols were scattered about. These people offered a striking contrast to the Chinese inhabiting the districts he had just left. They were strong and robust, with round, ruddy faces, very simple minded, and full of hearty good humor. They were entirely pastoral and nomadic in their habits, and did not take to agricultural pursuits. The old warlike spirit which made them so powerful in the days of Genghis Khan had now disappeared completely. The Chinese government had purposely encouraged the men to become Lamas, and now it was said that as much as sixty per cent. of the whole male population were Lamas, who by their religion were allowed neither to marry nor to fight. He then prepared to cross the desert of Hami, and after traversing the plain round Kuei-hua-cheng, ascended the buttress range on to the great Mongolian plateau. After crossing the Galpin Gobi, which Prejevalsky said was the most sterile part of the whole Gobi, he passed along the southern portion of the Hurku Hills. It was then of interest to find out whether the range extended as far westward as the Tien-Shan, or whether it formed a continuation of the Altai Mountains. Traveling along in a northwestern direction for 190 miles over a plain lying between the Hurku Hills and a similar but somewhat lower range running parallel to it on the south at an average distance of 30 miles, he descended into a low-lying, sandy tract very similar in character to the Galpin Gobi. The Hurku range there came to an end, its extreme length being about 220 miles. Not long afterward he approached the outlying spurs of the Altai Mountains, which were perfectly barren.

On some of the higher peaks to the north could be seen patches of snow. Pushing on toward Hami he got a distant view of the Tien-Shan or Celestial Mountains, at which point his desert journey ended, and he soon entered Chinese Turkestan. On descending the southern side of the Tien-Shan, he expected to enter a fine, well populated country, but instead of that he found the same barren desert as before, with, however, a small oasis every 15 or 20 miles with a village and cultivated lands. He at last reached Hami, having accomplished the distance of 1,255 miles from Kuei-hua-cheng in 70 days.

At Hami he had to make fresh arrangements for his onward journey to Yarkand, a distance of about 1,400 miles. Having reached Turkestan, he thought he would have been able to dispense with desert traveling, but was disappointed, for the whole country was really nothing but a huge desert, with villages and towns situated in the oases formed by the sucession of streams which flowed down from the Tien-Shan Mountains. The inhabitants were industrious, but not good cultivators. They seemed peaceful and contented, dressed simply and well, and lived in houses which, though built of mud, were kept remarkably clean inside. They stood in the greatest awe of the Chinese, who, without the least oppressing them, and without even an army of any size to cause it, yet produced an impression on the Turki mind of their overwhelming strength and importance.

After leaving Kami he went by road through Pidjan to Turfan, and then pressed on through Artush to Kashgar, where he was cordially received by M. Petrovsky, the Russian Consul-General. In Kashgar and Yarkand traveling merchants from all parts of Asia, and great numbers of pilgrims who had been to Mecca through India, were to be met with. They all declaimed loudly in praise of the English rule in India; they said that the English were the only people who really know how to govern a country. The Arabs were loudest of all in their praises of the English, for they had great respect for wealth.

The paper then went on to describe the journey from Kashgar until the Himalayas were reached, and then the crossing of the Tashkurgan Pass, the Chiragh Saldi Pass, and the Karakorun Pass. In crossing the Mustagh Pass they encountered great difficulties from the frequency with which large glaciers came across their path. The Sarpo Laggo River flowed down the glaciers of the Mustagh Pass, and after ascending it for a few miles they came in full view of the great peak K 2, the second highest mountain in the world—28,250 feet in height. The upper part for about 5,000 feet was a perfect cone, and seemed to be composed almost entirely of ice and snow, the accumulation of ages. The old Mustagh Pass to the east had been out of use for 30 or 40 years, on account of the accumulation of ice upon it, in consequence of which a new pass had been sought for, and another one to the west had been found. This latter pass had been in partial use up to ten years ago. No European had crossed either of them, but Colonel Godwin Austin in 1862 came very near the summit of the new pass from the southern side. In spite of many hardships from the want of provisions and the extreme coldness of the atmosphere, and with a weakened party, he arrived safely at Askoli on the Indian side of the Himalayas. Leaving Askoli, he went on to Skardo, and then through Cashmere to Rawul-Pindi, which he reached seven months after leaving Pekin. What had particularly struck him on his journey was that England ought to have small merchants or traveling agents of the larger merchants or agents of the manufacturers themselves pushing their way right into the interior, looking after the sale of their goods themselves, seeing that they were not subjected to any unlawful imposts, as European goods were now in their transit to the interior, examining the wants and tastes of their customers, and finding out what articles of native produce would be worth exporting.

At present European goods were allowed to take their chance after leaving the treaty ports, and the manufacturers seemed to have taken little or no trouble to adapt their manufactures to the tastes and requirements of the people for whom they were making goods. The Russians had acted on these principles, and had reaped their reward. The consul at Kashgar had told him, and he had himself observed, that all the bazars in Turkestan were filled with Russian cotton goods, and English goods could scarcely be bought there now. The chief reason for that was that the Russian goods were very much better suited to the people. England was handicapped in its competition with the Russians for the trade of Turkestan by having to bring its goods across the Himalayas. It was a fact worthy of particular notice that Russian piece goods were being brought over the Himalayas in gradually increasing quantities into the bazars of Ladakh and even of Cashmere.

A discussion followed the reading of the paper, in the course of which it was proposed and agreed to that the peak K 2 be henceforth known as Mount Godwin Austin, in honor of Colonel Godwin Austin, who 26 years ago surveyed a large area in its neighborhood.—*London Times.*

THE NEW KINGDOM OF ARAUCANIA-PATAGONIA.

THE attention of the civilized world has been so constantly directed to the south and east of Europe during the past decade or two that the creation of a new kingdom in the southern extremity of the American continent is almost unknown even to the reading public. Yet such is the case, and it is the intention of the writer to briefly review the most important historical facts and to present a sketch of the country and its resources.

Araucania is immediately south and southeast of Chili, being separated by the river Bio Bio, extending southward to the German colony of Valdivia and east to the eastward of the Andes. The coast line extends about two and a half degrees of latitude. The capital of the kingdom is Perquencot, and it is inhabited chiefly by Europeans and Creoles.

In 1540, the Araucanians fiercely defended the holy cause of liberty against the Spanish naval forces of Philip II., commanded by Don Garcia de Mendoza and Pedro Valdivia. In 1573, Chili, as a state, was conquered by the Spanish and made subject to the Viceroy of Peru, but Araucania, through its conspicuous valor and skillful resistance, maintained its proper independence.

In ancient times the Araucanians consisted of a powerful confederation, divided into four principalities. Each principality was governed by its own chief, called *toquis*, and each was independent of the others, except when uniting for deliberation in war against a common enemy, and for public welfare. The language is known as the Chilena, or Molucca, and the dominant religion a belief in a plurality of gods, similar, in some respects, to that of the ancient Greeks. They believe in metempsychosis and the immortality of the soul.

Patagonia, or Magellan's Land, was discovered by Magellan in 1519. It is a vast peninsular region, bounded on the east by the Atlantic Ocean, on the south by the Strait of Magellan, separating it from Terra del Fuego, on the west by the Patagonian Andes—leaving a narrow strip of undesirable, rocky land, controlled by Chili and Araucania—and on the north by the Argentine Republic. The northeasterly boundary is formed in part by the Rio Negro, the northern extremity of the country reaching to 34° latitude south, presenting a total length of territory of about 1,100 miles. The total area of Patagonia, east of the Andes, is about 300,000 square miles, while Araucania furnishes about 22,500 square miles additional.

The interior of Patagonia is inhabited by the Araucanians, or Puelchi, in the northern portion, and the Patagonians, or Tuelchite, properly so called, in the south. In the north are immense forests of cypress, pine, and oak, while the vast plains, extending eastward from the Andes, are covered with grass and shrubbery, and afford abundant pasturage for immense herds of cattle and horses.

The climate is mild and temperate in the north and rainy in the south. The lowlands are dry. Spring commences in September, summer in December, autumn in March, and winter in June. Epidemics are unknown, and the absence of venomous reptiles is a marked fact.

A better idea of the climate may be obtained from the products, such as cereals and fruits, the former being even now raised in sufficient quantities to admit of

exportation, and systematic agriculture has not yet been attempted. The fruits most raised are olives, figs, oranges, grapes, and apples, while hemp, tobacco, etc., are grown without the slightest difficulty. Minerals and ores are abundant, the most important being copper, iron, nickel, antimony, tin, mercury, agates, amethysts, silver, and gold. The most important silver mines, those which in ancient times yielded the greatest quantities of this metal, were closed at the time of the attack by the Spaniards under Mendoza, and have not since been opened, fearing that their working would precipitate new attacks by Chili and the Argentine Republic with a view to conquest.

In the year 1853, says Com. Talckes, the yield of gold reached 860,000,000 francs ($173,000,000), but at present the production is less than 500,000,000 francs ($100,000,000). The *Mining and Scientific Press*, in its issue of December 4, 1886, states that Mr. E. L. Baker, United States Consul at Buenos Ayres, has furnished information respecting recently discovered gold fields at the southern extremity of Patagonia. Several thousand claims have been disposed of to about 200 different persons, but it is said the best ground is owned by Messrs. Nield & Co. and Lezarna & Co. Mr. Baker says if it proves true that there is gold at Cape Virgenes it must be washings from the Andes, and that still farther inward it must be discovered in larger quantities. Parties are now prospecting the gulches nearer to the mountains. The way of approach from the east is from Buenos Ayres to Sandy Point *via* the Liverpool and Pacific steamer, thence by trail 150 miles to Cape Virgenes.

The better way of reaching this country from the Pacific side is to take one of the steamers of the German line which trade between Hamburg or Bremen and the Chili and Peru sea ports, and even as far north as Guatemala.

Perquencot, the capital, is situated in the northwest portion of the kingdom, east of the Andes, and, as has been stated, is inhabited chiefly by Europeans and Creoles—*i. e.*, descendants of the former. There are excellent shipping points on the Atlantic seaboard, but the harbor at Valdivia, on the Pacific, is said to be one of the best on the west coast of the American continent.

On the 6th of November, 1860, the nation offered the royal crown to M. De Tournans, who was placed upon the throne of Araucania and Patagonia under the name of King Orelio Antonio I.

M. De Tournans was a chivalrous and learned French citizen, who, being a lover of science, was carried into this distant region for the prosecution of that study and the observation of natural phenomena. Affable but modest, courteous, gentle, and charitable, he soon acquired the affections of the people, who subsequently elected him their king.

The first care of the new sovereign was to nominate a ministry; to give the people a constitution; to establish a succession to the throne in the line of direct descent; to establish the privileges of the king, and the unity of the people in the presence of the law. He divided the kingdom into departments and districts, under the control of prefects.

When King Orelio died without male issue, it became necessary for the country to elect a successor who should, in all respects, be as accomplished and as devoted to the welfare of the nation as the last sovereign. Such a one was found in the person of M. Gustave Achille Laviarde, Prince of Aucus, Duke of Kialeon. The nation acknowledged and confirmed him the sovereign of the free and independent states under the name of King Achille I. This act of recognition was officially confirmed by the chiefs and registered in Paris on the 26th of June, 1882.

Since that time consulates have been established in various cities in Europe, and efforts are now progressing favorably toward recognition of the kingdom by the Italian government. It is also learned from foreign journals that a company of wealthy merchants are endeavoring to obtain from the king permission to colonize certain portions of Araucania, to cultivate such cereals and fruits, and to secure hides, wool, and ostrich (*Rhea*) plumes, for which they find an excellent market.

A prominent writer regarding this government (in *L'Epee*, 1886) says: "France, through fear of becoming compromised with Chili and the Argentine Republic, is yet uncertain whether it ought to accord or not its protectorate to the people of Araucania and Patagonia, but it might in the end certainly intervene in this question, which is so warmly agitated, not only because they have solicited its protectorate through a chief who is French by birth and in heart, but lest it might repent too late the error committed when King Achille shall have accepted the protectorate offered by a nation so powerful as Germany."

Thus will be seen an exhibition of the feeling and desire, on the part of many Europeans, to secure speedy recognition of this new kingdom, as there is, without doubt, an excellent opportunity to establish commercial relations with a country rich in native products, which, if once accomplished, will be not only an impetus to the rapid development of the country itself, but it will be a source of wealth to the pioneers in commerce toward this portion of South America.—*Min. and Sci. Press.*

BLAKESLEY'S MARINE BAROMETER.

A VERY ingenious form of barometer has been recently invented by T. H. Blakesley, Esq., C.E., Assistant Professor of Physics at the Royal Naval College, Greenwich, which seems likely to have peculiar interest for nautical men.

It consists of a glass tube of some 20 inches in length, containing a column of a few inches of mercury; ten inches would be a convenient length. One end of this tube is open freely to the atmosphere; the other end, which contains a certain quantity of air, is closed. The tube is attached, for convenience of suspension, to a flat piece of wood furnished with a hook at each end, so that it may be hung up from either extremity; and it is graduated at intervals of about one-tenth of an inch throughout its length.

The following diagram will exhibit the position of the column of mercury in the two cases.

The principle of the instrument may be explained as follows: First let the instrument be suspended from the end which is open to the atmosphere.

Let l be the length of the column of mercury contained in the tube, and let a be the distance of the column from the bottom of the tube, determined by the reading of the graduated scale.

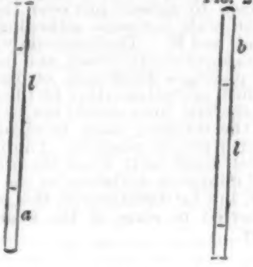
Also let π be the number of inches of mercury corresponding to the pressure of the confined air, and let x be the height of the barometer required.

Then we have from Fig. 1 the equation

$$\pi = l + x.$$

Next, let us suppose the instrument suspended from the other end, so that the lower extremity is now open to the atmosphere, and let us suppose that the air which formerly occupied a inches of the tube now occupies b inches.

FIG. 1 FIG. 2



Then by Boyle's well-known law, the pressure of the confined air, formerly represented by π, is now equivalent to $\frac{a}{b}\pi$. And from Fig. 2 we have the equation

$$x = l + \frac{a}{b}\pi, \text{ or } x - l = \frac{a}{b}\pi.$$

Dividing one of our equations by the other we obtain

$$\frac{x+l}{x-l} = \frac{b}{a},$$

which becomes

$$x = \frac{b-a}{b+a}\,l,$$

a simple relation which, at the expense of a trifling arithmetical calculation, gives the height of the mercurial barometer with great accuracy.

The labor of computation, never very great, is, of course, least when, as in the present case, 10 is taken as the length of the column to be used.

The advantages claimed for this instrument are several:

1. It is a matter of common experience that observations with the ordinary barometer are, more or less, vitiated by the imperfection of the vacuum in the upper part of the tube, an imperfection which it is almost impossible altogether to obviate. In Mr. Blakesley's instrument, the actual quantity of air in the closed end is absolutely unimportant, provided that it remains the same at both observations, which is, of course, the case.

2. The ordinary barometer can hardly be less than 36 inches in length, whereas in the new invention 20 inches is ample. This is an important consideration, when, as is often the case afloat, only limited accommodation is available for stowage.

3. The instrument is so exceedingly simple in construction that it can be produced at less than half the cost of either the ordinary or aneroid barometer.

4. When the present barometer is preferred for ordinary use, the new form may be used with considerable advantage as an occasional check upon the indications of the ordinary one, since the only element which bears room for uncertainty, viz., the length of the column, l, can be readily determined by actual measurement.

The instrument, which is expected to be ready for issue to the public in a very few weeks, may be obtained of Messrs. Watson & Co., 4 Pall Mall, S. W.—*Nautical Magazine.*

THE WYOMING OIL FIELDS.*

IN order to present a clear and intelligible report on the oils sent to me, at various times during the last four months, I deem it necessary to divide my subject into the following points, namely: The Geological Structure of the Territory, A Description of the Oil-bearing Districts, The Analysis, A Comparison with the Pennsylvania Oils, and, lastly, The Extent of the Oil Supply.

THE GEOLOGICAL STRUCTURE OF WYOMING.

From the annual reports of the United States geologist† and the territorial geologists, Professors Samuel Aughey, Ph.D., LL.D.,‡ and Louis D. Ricketts, D.Sc.,§ we learn that Wyoming enjoys a complete geological history of the rock formation, from the very beginning of the Archæan era to the present time, without a single break or member being missing: and that, in some localities, the whole series of stratification lies open for our inspection. Beginning from below and ascending, we find the older rocks below the Triassic thinly represented, and not over 2,500 to 3,000 feet thick. The granite tops of the Laramie mountains indicate that since the Laurentian period they have always been above water. The metamorphic rocks of the Huronian period are visible in Canon mining district; the Cambian system is very thick in the southwest, while the Devonian rocks, which are so abundant in the East, are, according to King, supposed to exist in thin strata. The limestones and sandstones of the carboniferous age are to be seen in the Little Popoagie canon and on the Rattlesnake Range, with an abundance of fossils.

Resting conformably on the Paleozoic rocks, and merging into each other, lie the brilliant red sandstones of the Jura-Trias, which, in the Wind River mountains, reach a thickness of 2,000 feet. We next come to the cretaceous rocks, the best developed and most important in the whole series. They are from 5,000 to 6,000 feet thick, and are divided into four groups, the Dakota, Colorado, Fox Hills, and Laramie, consisting mainly of a coarse conglomerate firmly cemented, porous sandstone and sandy shales, but no limestone. Every one of these groups has oil springs or contains strata whose croppings are saturated with oil. The Dakota group at the bottom, however, is by far the most promising in oil yield. It is from 50 to 600 ft. thick, and may be reached at a depth of 2,000 ft. With one single exception, no petroleum occurs in any other than the cretaceous rocks. The exception is the Shoshone oil. This is found at a lower horizon, namely, at or near the bottom of the Triassic or the top of the carboniferous formations, not in the cretaceous.

When the last white sand rock of the Laramie group was laid, rich in its mineral wealth, building stone and iron and the vast deposits of lignitic coal were securely bedded between its sandstone and shale, Wyoming, until then undisturbed in the even tenor of its rock building, received its present topography, by the gradual tilting of its strata into mountain chains and bold escarpments. Though in the succeeding Tertiary age active volcanoes lit up the Sierra Shoshone, and other dynamic disturbances left their impress on the rocks, their effects were too limited and gradual to materially affect the oil-bearing strata. Both the Tertiary and Quaternary formations are complete, and reach a thickness of 8,000 ft. But as a reference to these does not bear on our subject, I pass on to a brief

DESCRIPTION OF THE PETROLEUM DISTRICTS.

When, in the year 1861, the enterprising Edward Creighton was carrying out his bold sceme of uniting the two oceans by telegraph, he greased his transportation wagons with Wyoming oil and pronounced it a first-class lubricant. Little attention, however, was directed to the fact until within the last few years, when prospecting for oil has gone on apace. Oil has been discovered in every county except one, Albany County. It is found near Evanston, in the southwestern portion of the Territory, and at frequent springs on Twin Creek, along the Oregon Short Line. There are oil wells, but little known, on Stinking Water River, in the northwest; on the Nowood River, to the west of the Big Horn Mountains, as well as on its eastern and southern flanks; over a large area of Cook County, in the northeast, notably along the Belle Fourche River. Rock oil was lately discovered 15 miles from Sherman, in Laramie County; and, no doubt, Albany County will soon be heard from as completing the list, thus making the entire Territory productive of oil.

But the best oil belt lies in the heart of Wyoming, in what is known as the Rattlesnake district, extending from Fort Casper, the present terminus of the Fremont, Elkhorn, and Missouri Valley R.R., westerly along the northern slope of the Rattlesnake Mountain range and Beaver Mountains to the foot of the Wind River Mountains—a distance of over 100 miles, with a varying breadth of from 30 to 50 miles. This vast basin, like the celebrated Bradford oil field in Pennsylvania, the hitherto greatest known oil deposit on the American continent, distinctly shows the outlines of an ancient sea bed, along whose shores are scattered the various oil wells that have attracted so much attention. For ages back, before the white man ever set foot on Wyoming soil, the oil flowed and went to waste, solidifying on exposure to the atmosphere in many places, principally in the Shoshone Indian reservation, where, I am told, there are lakes and entire acres covered three feet thick with this oil cake, destitute, it is true, of the lighter products of petroleum, which were absorbed by the soil or evaporated in the dry atmosphere, but rich in the heavier products, and forming an invaluable fuel.

The oil belt just described is divided into four separate basins, each basin containing a different shade or quality of oil. At the remote western end are located the Shoshone oil wells, covering an area of 60 acres, the daily output of which was estimated by Prof. Aughey, in 1881, at 50 barrels, with 600 barrels in the pits. The escape of a great amount of carbureted hydrogen gas over the entire area and eleswhere indicates a large reservoir of oil in the rocks beneath. Thirty-five miles directly east of this basin is situated the Beaver oil basin. Over an area of $1\frac{1}{4}$ mile to $\frac{5}{8}$ of a mile, the rocks are more or less saturated with oil, and gas is everywhere escaping. The structure of this and the preceding basin is that of a circle produced by true anticlinal folds, extending a depth of 2,000 ft. to the oil-holding strata.

The Rattlesnake basin lies 35 miles due east of the Beaver, and covers an area of 1,120 acres. Long lines of hogbacks of the Dakota group, divided by four canon creeks, characterize this region, and retain the oil in the brown sandstones and puddling stone conglomerate. Here, over a space of four miles, the oil is alike in every known particular, and, as its great specific gravity and jelly-like consistency prevents it from spreading far laterally, it would indicate a huge underground reservoir, four miles in length by about 400 ft. wide and 1,500 ft. deep.

The Seminole basin is situated about 27 miles east of the Rattlesnake. It embraces 640 acres in anticlinal rocks, one well being calculated to yield 50 barrels daily at a depth of 100 ft., and, if bored down to the proper oil-bearing strata, would certainly yield a large supply. Prof. Aughey considers that if these oil wells were worked on business principles, they would speedily develop into properties worth millions. Prof. Ricketts states that of the 19 wells which have been drilled for oil up to date, five produce from five to several hundred barrels a day, and the remaining 14 have not reached the oil horizon.

It is difficult to state the precise amount of oil treasured up in the Wyoming rocks, or to point out the localities where the yield would justify the erection of the necessary machinery. Mr. I. I. Maken, an old resident, familiar with every path and brook within five counties, testifies that all the reports about Wyoming oil are true, but do not give the Territory credit for what it is worth. He can point out a well the output of which is 10,000 gallons of green oil per day. He can show a thousand and one oil springs of different sizes and at different locations, and he has seen many which flow from 2,000 to 3,000 barrels a day.

The greatest impediment, in fact, the only impediment, to their development is the want of railroad facilities. This want will speedily be supplied. The

* A report on an analysis of the crude oils of Wyoming to the Omaha Petroleum Company, by Prof. Jos. Rigge, S. J., Creighton College, Omaha.

† Twelfth Annual Report of the United States Geological and Geographical Survey of the Territories of Wyoming and Idaho, for the year 1878, by F. V. Hayden, United States Geologist.

‡ 1881.

§ January, 1888.

Chicago and Northwestern is within a few miles of Fort Casper, the eastern end of the oil belt, and is now setting its stakes into the very center. The Burlington and Missouri and the Union Pacific have both surveyed into this field. The Central Pacific already enters from the west, and the Northern Pacific will come in by the Big Horn Valley. Already twelve companies composed of wealthy capitalists from Omaha, Denver, Chicago, Milwaukee, and from the East, with capitals ranging from $200,000 to $5,000,000, have been incorporated, and propose to commence active work this spring. That Pennsylvania men are the most active in the field is significant; for it implies a good quality of oil. This brings us to the

ANALYSIS OF THE OILS.

The analysis embraces samples from the Shoshone, the Big Horn, the Rattlesnake, and the Seminole wells. The *Shoshone* is a mineral oil, intensely black, but of a deep cherry red when viewed, in thin sections, by transmitted light. In its crude state it forms an excellant lubricant. It is of a high specific gravity, 20° Baume; singularly free from gumming, unaffected by a cold at 0° F.; has a flashing point of 292° F., and a burning test of 321°.

In its distillates it is superior, in quality, to the best Bradford oil, as may be judged from the various samples obtained from the crude and subjected to the refining process. They are the following:

	Color.	Per cent.	Spec. gr.	Baume.	Flashing point, F.	Burning point, F.
Naphtha....	....	0·50	......	....	....	....
Kerosene..	Water-white, sparkling.	17 50	0·763	53°	190°	210°
	Light straw-colored....	41·50	0·780	50°	170°	212°
Lubricator, "neutral"...	Light yellow, odorless,	18·00	0·845	36°	308°	403°
	Amber, strong odor	12·50	0·845	36°	304°	392°
Coke	....	10·00	......	....	....	....

These oils, with the exception of the naphtha, are the result of a process of purification and redistillation, my primary object being to present to the company samples of good oils which could be obtained from the crude, rather than to make a detailed showing of all its distillates. If this had been the intention, the first kerosene would have been of a lighter gravity (60° B.) and a lower fire test; and the last lubricant of a dark brown color and higher gravity (34° B.). These first distillates were all thrown together, purified with sulphuric acid and alkalies, washed, returned to the still, and filtered through bone black; the residue being a lubricator of the color and consistency of pitch, which may serve to lubricate heavy machinery or be added to a new charge of the crude oil.

I am inclined to the opinion, however, that, owing, perhaps, to the absence of paraffine, the Shoshone oil may be somewhat unstable. What leads me to this opinion is the fact that an analysis of the same oil made three months afterward was found wanting in the lighter volatile oils, the fire test somewhat lowered, with a very decided absence of the pungent coal oil odors experienced in the first process. The hardened oil crusts found in the Shoshone basin go to strengthen this opinion. Be this as it may, the value of the oil suffers little loss; for thus deprived of the light products, it may serve as a base to give body and tone to inferior material from the East.

What I have called "neutral" oil is the very best jeweler's lubricator, pouring like water; so superior indeed that when 95 per cent. of it are mixed with 5 per cent. of sperm oil, it may be sold for the very purest sperm; and, when mixed with a little of any heavier oil, it will form admirable lubricating compounds for general purposes, when very high speed is not required; since its high fire test can afford to be lowered to 300°.

If, on the other hand, it be desirable to increase its gravity and brilliancy, but to lower the fire test of the light oil, it may be effected by exposing it in narrow tanks to the sunlight. The fluidity of an oil is, to a large extent, a measure of its value; for, as a rule, the best lubricant is that having the least viscosity, combined with the greatest staying property, or adhesiveness to the journal.

The *Big Horn* oil is deep green by reflected light and ruby red by transmitted light. Its gravity is 30° Baume. It flows very freely, forms a good lubricator, adhesive, standing a low cold test and a high fire test, its flashing point reaching up to 477°, and burning point to 545°. The following gives an idea of its products:

	Baume—Sp. gr.	Per cent.	Temp. F.
Gasoline...............	....	1·5	80°–212°
Benzine	58° =0·745	2·5	212°–310°
Kerosene...............	41·5°=0·815	46·0	310°–420°
Sperm oil..............	26° =0·897	33·5	420°–500°
Paraffine..............	....	12·5	500°– ?
Residue	....	4·0	....

By submitting the above heavier products, excluding the two first, to purification and redistillation, the beautiful, sparkling sample oil forwarded to the company was the result. It resembles the "neutral" oil mentioned under the head of Shoshone oil, which we may call the best quality of spindle oil. Of this lubricant is obtained about 90 per cent. from the mixed products, making nearly 80 per cent. in the crude. This oil is of 36° Baume, stands a flashing test of 346° and a fire test of 400°.

Since writing the above, I had the pleasure of seeing Prof. L. Ricketts' report of the Nowood oil. This oil is found on the western side of the Big Horn Mountains. The report reads as follows:

"The Nowood oil is light green in color by reflected light, and a sherry red by transmitted light. It is but slightly viscous and pours like milk. Its gravity, as taken by myself, is 31½° Baume. The following is the result of a fractional distillation of a sample of this oil by Walter H. Kent, Ph.D., of Brooklyn, N. Y., chemist of the department of health:

	Per cent.	Spec. gr.	Baume.	Temp. C.
Gasoline................	2·05	0·7967	46·7	26°–100°
Naphtha	3·02	0·8109	43·5	100°–130°
Benzine	3·89	0·8189	41·8	130°–160°
Kerosene	28·47	0·8461	30·1	160°–210°
Mineral sperm oil......	42·97	0·8439	36·6	210°–260°

Specific gravity, 29·2° Baume = 0·8822."

The residue of the Big Horn oil is mainly paraffine, which, when purified, will be of great value, under the name of vaseline, in the preparation of perfumes, ointments, and as a substitute for olive oil in the kitchen; since it is free from smell and taste, quite harmless, keeps indefinitely without becoming rancid, and has no chemical action on any medical ingredient, and, therefore, remains unchanged for years.

Owing to a violent frothing in the retort of the other two sample oils, namely, the Rattlesnake and the Seminole, considerable difficulty was experienced in distilling them. This difficulty was removed by making use of one or other of two methods. The first is to treat crude oils with turpentine, which dissolves and renders them liquid, but has the inconvenience of tainting the first distillates with its strong, persistent odor. The second method is to use a larger retort, capable of holding five times the amount of oil to be distilled, and to carefully regulate the heat. This latter method was preferred, and the oils sent to the company are the result by this process. It may be remarked here that these oils come from the neighborhood of the soda lakes, and show alkaline reactions on red litmus and white phenolphthalein paper.

The *Rattlesnake* is a very thick, viscous oil, scarcely flowing. It is of a dark brown color, akin to black, by reflected light, with a greenish tinge around the edges, and of a dark mahogany color when exposed, in thin sections, to transmitted light. The sample used for analysis seemed to be rather old and impure. Its specific gravity is that of water—10° B. Its flashing point is 358°, and burning point somewhat over 400°. A cold test of 20° F. seemed not to affect it, and a drop exposed on an inclined plane for three days had advanced five inches and was still as soft as on the first day. It contains 49 per cent. of water; 29 per cent. of a deep yellow lubricating oil, 0·928 spec. gravity, or 21° Baume; 16 per cent. of vaseline; and 6 per cent. residue not soluble in ether, but somewhat in turpentine, and probably containing resin. When purified and redistilled, this lubricating distillate, with what oil could be expressed from the paraffine, gave an excellent "neutral" oil of 26½° Baume = 0·895, deep yellow in color, with flashing point at 401° and fire test at 418°. From a thin black layer formed on the surface of the crude oil after standing awhile, as well as from its correlation to the other Wyoming oils, it may be inferred that, if this lighter crude oil were drawn at the wells, instead of the heavy, impure sample sent to the college, a lighter lubricant and good illuminating oil might be extracted.

The *Seminole* oil is sea green by reflected light and sherry red by transmitted light. It lower section or sediment is of a dark oak grained color. The flash point of the oil is 498° and burning point 518°; specific gravity, 0·922 = 22° Baume. In viscosity and cold test it is not inferior to the other oils. It consists of 18 per cent. of water of milky appearance; 28 per cent. of a beautiful light yellow and odorless spindle oil, of 29½° Baume (0·878), with a fire test of 400°; 29 per cent. of an illuminant, 44° Baume (0·803), odorless, light yellow, flashing at 250°, and burning at 288°; 23 per cent. of a deep yellow illuminant, 38½° Baume (0·830), with fire test of 329°. The residue, 2 per cent., was coke; there was no paraffine. These distillates show a strong phosphorescence.

Having an oil cake sent two years ago from the Shoshone Indian reservation, I was rather curious to know what distillate it would give. Accordingly, two ounces of it were weighed and cut into small pieces, placed in the retort, and distilled, like the preceding, under cover. The result was an illuminating oil, of a dark rose color, specific gravity 0·814 = 42° Baume, flash point of 232° and burning test of 253°. The greater part caked in the retort under a higher fire; but, if the hardened oil were mixed and softened at the start with a little crude oil, the result might be an increased yield of valuable oils. The residue forms the very best fuel.

While experimenting with the crude oils and mixing them with chemicals in varying proportions, with the application of heat, for the purpose of solidifying them, although not meeting with complete success, I consider it feasible to convert them into a solid fuel, which will be destitute of the heavy smoke so characteristic of the hydrocarbons, and possess calorific properties far superior to the best anthracite.

In perusing the above analyses of these Western oils, the question must naturally have forced itself upon the mind,

HOW DO THESE WESTERN OILS COMPARE WITH THE EASTERN?

We shall briefly elucidate this point. From the foregoing description of these oils, it will be seen that they are of a higher gravity than the Pennsylvania oils, and consequently contain a larger proportion of lubricants; although they all have good illuminating oils, the Shoshone over 50 per cent. of the very best kerosene. These lubricants are of superior quality and the finest in the world; even the residues in the retort may serve for pitch, fuel, or lubricators for heavy machinery. Everything in the oil is of value, nothing goes to loss. One of the leading scientists and chemists of Cleveland, Ohio, says of the solidified oil that "it would make the best base of any material known to oil men, if they could get it to Cleveland to mix their lighter oils with. This would enable them to make the best of oils known from their inferior material."

This is certainly a strong indorsement of Wyoming rock oil, and if applicable to the hard oil crust, grows proportionally more valuable when referred to the fluid oil.

"A government expert from the East, who collected samples of these oils, gives us the following very satisfactory idea of their superior value:

"1. A fuel oil, or the gasoline of commerce. This is, in all respects, equivalent to the standard product.

"2. A clear, water white kerosene of 175 degrees fire test, odorless and sparkling, and with body and illuminating quality unexcelled by any, so far as any ordinary test can determine.

"3. A high test oil made with a special reference to the safety of railway and steamship travel. This is 300 degrees fire test, and cannot be lighted except through the agency of the wick.

"It is claimed for oil of this high test that it will not explode or ignite, although the lamp containing it be broken in pieces while burning. This is also water white and odorless.

"4. Spindle oil, a very fine lubricant, especially designed for very fine machinery.

"5. Vaseline, which is valuable in many directions."

Prof. Aughey, LL.D., who on two occasions explored Wyoming, gives it as his candid opinion that these oil basins, if worked on business principles, as they are done in the East, will speedily develop into proportions worth millions. This opinion is indorsed by Messrs. Wyner & Harland, public analysts, of London, England, who analyzed these oils. As conclusive testimony on this subject, I refer to a letter of Mr. H. K. Taylor, chemist of the Standard Oil Company, Cleveland, Ohio, dated August 27, 1881, in which he says:

"As regards the Wyoming oils, I do not know that I can add anything to what I have already written. If they exist in paying quantities, they can be made to duplicate the various oils made and produced in this region. Your 14½° Beaver oil would furnish a basis for a cylinder oil equal in quality to valvoline, I think, by treating and compounding. The cherry-colored oil would make the various light-colored machine oils. The Shoshone is profitable enough as a dark axle oil. The 5° oil (Rattlesnake) can be utilized as a lubricator by mixing with grades of a lighter gravity. . . .

"Does the Beaver region give promise of a large yield without losing more than 10° on gravity? If so, it is an immense fortune in itself."

The superior value of these Wyoming oils over the Eastern products being thus established by these eminent authorities, the next and last point to be investigated is:

Do *these oils exist in paying quantities*, or is there any indication to lead us to surmise that, as the Pennsylvania oil reservoirs have steadily declined since 1882, and before another generation shall have passed away will have been pumped dry,* the Wyoming oil supply will be similarly affected?

To give a satisfactory answer to this all-important question, we must know the thickness of the oil-bearing strata and the extent of their croppings.

From the brief exposition of the geological formation of Wyoming, it will be remembered that the matrix or source of the petroleum in the West is entirely different from what it is in the East. The petroleum in the Appalachian Mountain system, and throughout Ohio, Kentucky, Virginia, and Tennessee, has its birth in the sandstone shales or slates of the Devonian age or in the Trenton limestone of the Lower Silurian, and is received in strata whose loose texture hold the oil in suspension, as water is absorbed by a sponge; but in Wyoming, the Devonian rocks are almost entirely absent, and later formations referring to the concluding period of the Mesozoic era, namely, to the Dakota group, are the oil-bearing reservoirs. These strata were laid millions of years after the Eastern oil fields were already wasting their precious perfume on the desert air. There is, however, some analogy between the two oil fields. As in Pennsylvania the oil-bearing strata are composed of sandstone, shale, and slate, having been laid in quiet seas whose gradual depression kept pace with the supply of sand and animal and vegetable debris spread over its bottom, so in Wyoming do we meet with the sandstone, shale, and slate, bearing evidence of being shore and off-shore deposits of an ancient sea. A reference to the map of Wyoming will show that it is studded with mountains. These mountains were the shore lines of primeval seas, in which were laid our oil-soaked rocks. The plunge and flow structure of the Dakota rocks is common from the bottom to the top, showing that they were laid on slowly subsiding bottom. Mr. Caril bears evidence to a similar structure of the Pennsylvania oil tanks.

In Pennsylvania the luxuriant vegetation of the carboniferous age overlies the Devonian rocks; in Wyoming the great coal measures of the Laramie group are bedded conformably over the oil-bearing Dakota. In both regions do we find natural gas associated with and escaping in abundance from the oil wells. But the Pennsylvania oil rocks are only from 1,200 to 2,000 feet thick; in Wyoming the petroleum strata average a thickness of 5,000 to 5,500 feet, or nearly three times as thick. Judging from the extent of area over which oil has been found, and the prolific yield of the few wells which have been sunk to the proper oil horizon, bearing also in mind the important fact that, unlike the Eastern wells, all the Wyoming springs produce oil similar in gravity, color, and main qualities, the petroleum of Wyoming, in quantity and quality, promises to be correspondingly great and enduring. Nothing but an immense reservoir, practically exhaustless for centuries to come, can underlie Wyoming. This is the logical inference we draw from the thickness of the oil-bearing cretaceous rocks and the common origin of the oils.

The above facts in themselves point to Wyoming as the future oil market of the United States. Already Eastern oil men have realized the fact; Omaha enterprise is working to direct part of this vast industry into its own channel, and is contemplating the feasibility of piping the oil down the Platte Valley—a distance of 650 miles—into its refineries. Add to this the vast soda lakes, which exceed the total amount now employed in the various soda manufactories of the world; the magnificent gypsum beds equaling the purity of Italian marble; the vast coal deposits of lignite, bituminous, anthracite, and coking coal—one seam of which has been traced 175 miles; think of the good hematite, the copper, gold, and silver beds of the carboniferous rocks, the rich timber, building stones, the mild climate of the valleys, and it will not appear preposterous to see from the hitherto unknown Territory of Wyoming loom up the future "Empire State" of the Union.

* The reader is referred to a paper read by Charles A. Ashburner, M.S., C.E., before the American Institute of Mining Engineers, at the Halifax meeting, September, 1885.

THE MINERAL RESOURCES OF CANADA.

THE mineral resources of British North America have up to the present time been almost neglected, and are but little known or appreciated, notwithstanding the fact that Canada has expended annually for many years very large sums upon the geological survey, and published as long ago as 1863 Sir Wm. Logan's admirable geological report. Though the fact is not creditable to the "powers that be," it must be admitted that nearly all the knowledge we have of Canada's useful minerals is that furnished in the work of that eminently practical and progressive engineer and geologist. During the past two years the geological survey has again commenced publishing information that has practical value, and which will tend to direct attention to its mineral resources, which are vast and rich beyond any conception that has yet found place in the public mind.

Even the best known mineral districts, the magnificent coal, iron, and gold fields of Nova Scotia and Cape Breton, the copper deposits of Newfoundland, the gold washings of the Chaudière, Quebec, the phosphates, asbestos, iron, copper, gold, and silver of Ontario, though known and worked for many years, are still but infant industries, and it is difficult to convince capitalists in this country that the deposits can amount to much, because they hear so little of them, and their output is so comparatively insignificant after so many years' development.

The Canadians themselves are ignorant of most of the vast mineral riches their country contains, and comparatively indifferent to what they do know, so that the revelations of a recent parliamentary committee report on the Great Mackenzie Basin are as unexpected there as here. According to this report, as summarized in the New York *Times*, the area of the Great Mackenzie Basin is given as 1,260,000 square miles, and in this are not included any of the islands of the Arctic Archipelago. The coast line on the Arctic Ocean and Hudson's Bay, exclusive of inlets, measures 5,000 miles. Over one-half of this coast line is accessible to whaling and sealing craft. The total area of the lakes probably exceeds that of the Eastern Canadian-American chain, and the navigable coast line of the larger lakes of the region is about 4,000 miles. There is river navigation in the region to the extent of 2,750 miles, half of which is suitable for stern-wheel steamers, which, with barges, may carry 300 tons. The other half is deep enough for light draught seagoing steamers. A total of 6,500 miles of continuous lake and river navigation is broken in two places. One of these occurs on the Great Slave River, and to overcome it a 20 mile wagon road is now under construction from Fort Smith southward. The other break consists of 70 miles of the Athabasca River, above Fort McMurray. In these 70 miles, rapids are unpleasantly numerous. The committee states that flat boats can descend, but cannot ascend them.

The immense lacustrine area of the northern and eastern portions of the territory implies, the committee thinks, the future supply of a great part of the North American continent with food fish.

In the Great Mackenzie Basin there is, in the committee's opinion, a possible area fitted for the growth of potatoes of 656,000 square miles; suitable for barley, 407,000 square miles; and suitable for wheat, 316,000 square miles. The pasturable area is placed at 860,000, of which 26,000 miles is open prairie. Including the latter, 274,0 0 square miles, the committee states, may be considered arable. Of the total area, 400,000 square miles is useless for the pasturage of domestic animals or for cultivation.

The forest area contains the liard, a balsam poplar, which attains a growth of 120 feet in height and a stump diameter of 6 feet; the white spruce, 150 feet high, with a stump diameter of 5 feet; the larch, of about the same size; and the banksian pine, which has a straight stem 100 feet high, with a stump diameter of only 2 feet.

Of the minerals of this vast region little is known. Nothing is known of the minerals which may exist east of the Mackenzie River and north of the Great Slave Lake. Enough is known of the western affluents of the Mackenzie, the committee thinks, to show that at the head waters of the Peace, Liard, and Peel rivers there are from 150,000 to 200,000 square miles which may be considered auriferous, while west of the Rocky Mountains there is a metalliferous area, principally of gold-yielding rocks, 1,300 miles long and from 400 to 500 miles broad. Gold has been found on the west shore of Hudson's Bay, silver on the Upper Liard and Peace rivers, and copper on the Copper Mine River. Iron, graphite, ocher, brick and pottery clays, mica, gypsum, lime, sandstone, and asphaltum are also known to exist in the region. Salt is found in crystals and in saline springs.

The evidence submitted to the committee points, in the language of the report, to the existence in the Athabasca and Mackenzie valleys of the most extensive petroleum field in America, if not in the world. The committee suggests that 40,000 square miles of this territory be for the present reserved from sale, as it is probable that in the near future petroleum will rank among the chief assets of the Dominion. The committee bounds the reserved lands as follows: Easterly by a line drawn due north from the foot of the Cascade Rapids on Clearwater River to the south shore of Athabasca Lake; northerly by the said lake shore and the Quatre Fourche and Peace rivers; westerly by Peace River and a straight line from Peace River Landing to the western extremity of Lesser Slave Lake; and southerly by said lake and the river discharging it to Athabasca River and Clearwater River as far up as the source.

DETECTION OF COTTON SEED OIL IN OLIVE OIL.

By ERNEST MILLIAU.

IN a porcelain capsule, holding about 1 liter, 15 c. c. of the oil in question are heated to 110°. Then, while still continuing to heat, we pour upon the oil a mixture of 15 c. c. of a solution of soda at 40° Baumé in distilled water and of 15 c. c. of alcohol at 92 per cent. When the mass has become homogeneous, we add, drop by drop, so as not to cool the paste and form clots, about ½ liter of distilled water. After boiling for a few minutes, we separate the fatty acids by means of pure sulphuric acid diluted to one-tenth. As soon as the separation is complete and the sulphuric acid is in slight excess, 5 c. c. of the hydrated fatty acids are collected with a silver spoon and poured at once into a test tube, about 3 cm. in diameter and 12 in length. We add 20 c. c. of alcohol at 92° per cent., and heat slightly in the water bath to dissolve the fatty acids. When the solution is effected, 2 c. c. of a solution of silver nitrate (30 grms. in 100 c. c. of distilled water) are added, the tube is placed in the water bath and heated until about one-third of the mass is evaporated. The tube is then removed from the water bath. Whatever is the origin of the olive oil, its fatty acids remain unaltered if the oil is pure. But if cotton seed oil is present the silver is reduced, and blackens the fatty acids which rise to the surface. In this manner 1 per cent. of cotton seed oil can be detected in olive oil.

REPRODUCTION OF PHARMAKOLITE. — H. Duet.—The author obtains calcium arseniate in a crystalline state, identical in form with the crystals of natural pharmakolite. The composition of pure crystals is given as $2CaO,HO,AsO_5+4HO$, in opposition to the formula $2CaO,HO,AsO_5+5HO$, deduced from the analyses of Klaproth and Rammelsberg.—*Comptes Rendus.*

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